# STAR

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# INTRODUCTION

## WHAT *STAR* IS

***Scientific and Technical Aerospace Reports (STAR)*** is a comprehensive abstracting and indexing journal covering worldwide report literature on the science and technology of space and aeronautics. It is published on the 8th and 23rd of each month.

The following publications are abstracted in *STAR*:

Scientific and technical reports of the National Aeronautics and Space Administration and its contractors; scientific and technical reports of government agencies, universities, and research organizations throughout the world.

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The first section of *STAR* contains citations and abstracts arranged in 34 subject categories. Following are six indexes: subject, personal author, corporate source, contract number, report/accession number, and accession/report number. Separate cumulative indexes are published quarterly, the fourth quarterly being an annual index for the calendar year.

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By arrangement between NASA and the American Institute of Aeronautics and Astronautics, the AIAA publication *International Aerospace Abstracts* is issued in coordination with *STAR*. Each journal appears on alternate weeks. *IAA* uses subject categories identical with those in *STAR*, and publishes similar indexes. *IAA*'s worldwide coverage of books and journals complements *STAR*'s worldwide report coverage. The two publications thus provide comprehensive access to current literature on aerospace science and technology.

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The Preliminary Edition of the *NASA Thesaurus* (December 1967) (NASA SP-7030) is used as the authority for the indexing vocabulary that appears in the subject index. The *NASA Thesaurus* should be consulted in examining the current indexing vocabulary, including associated cross-reference structure. Only the subject terms that have been selected to describe the documents abstracted in this issue appear in the subject index. Copies of the *NASA Thesaurus* may be obtained from the Clearinghouse for Federal Scientific and Technical Information or the U.S. Government Printing Office at $8.50 for the three-volume set.

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Includes aerodynamics of bodies, combinations, internal flow in ducts and turbomachinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion. **395**

**02 AIRCRAFT**
Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **398**

**03 AUXILIARY SYSTEMS**
Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems. **400**

**04 BIOSCIENCES**
Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology. **409**

**05 BIOTECHNOLOGY**
Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences. **416**

**06 CHEMISTRY**
Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants. **420**

**07 COMMUNICATIONS**
Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **432**

**08 COMPUTERS**
Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics. **435**

**09 ELECTRONIC EQUIPMENT**

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation. **442**

**10 ELECTRONICS**

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories. **445**

**11 FACILITIES, RESEARCH AND SUPPORT**

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**12 FLUID MECHANICS**

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion. **451**

**13 GEOPHYSICS**

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences. **459**

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Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras. **468**

**15 MACHINE ELEMENTS AND PROCESSES**

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; reliability; drafting; and materials fabrication, handling, and inspection. **473**

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**18 MATERIALS, NONMETALLIC**

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**32 STRUCTURAL MECHANICS**

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic. **574**

**33 THERMODYNAMICS AND COMBUSTION**

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants. **580**

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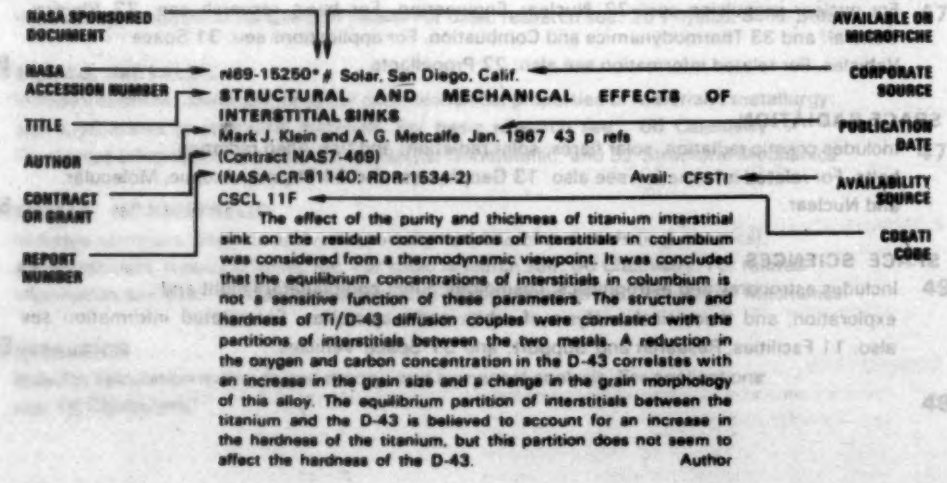
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N69-15250* # Solar, San Diego, Calif.
STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
(NASA-CR-81140; RDR-1534-2)
Avail: CFSTI
CSCL 11F
The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

VOLUME 7 NUMBER 3 / FEBRUARY 8, 1969

# Scientific and Technical Aerospace Reports

*A Semimonthly Publication of the National Aeronautics and Space Administration*

## 01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

**N69-12940** Cornell Univ., New York.
**AN ASYMPTOTIC THEORY OF THE HIGH-ASPECT-RATIO JET FLAP**
Keith Prior Kerney (Ph.D. Thesis) 1967 80 p
Avail: Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 68-881

The method of matched asymptotic expansions in inverse aspect ratio is used to obtain a solution to the problem of steady, irrotational, constant-density flow past a thin, high-aspect-ratio, unswept wing with jet flap. The lift, induced-drag, and pitching-moment coefficients are expressed as quadratures with integrands involving the wing and jet sectional characteristics. The theory is applied to a flat, elliptically loaded wing for comparison with two earlier theories. The three theories give the same expression for the ratio of the induced-drag coefficient to the square of the lift coefficient but different expressions for the lift coefficient itself. Experimental results for the case of a wing at zero incidence with a jet deflection of 31.3 degrees indicate agreement with the present theory is excellent at an aspect ratio of 6.8 and good at an aspect ratio of 2.75. The two earlier theories are discussed and the validity of certain approximations used in deriving them is questioned. Dissert. Abstr.

**N69-12941** Connecticut Univ., Storrs.
**THE AEROELASTIC BEHAVIOR OF ROTARY WINGS IN FORWARD FLIGHT**
Andrew Zachery Lemnios (Ph.D. Thesis) 1967 119 p
Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 68-1370

The analysis is divided into three major phases: (1) calculation of blade airloads, including real airfoil effects, nonlinear rigid body dynamics, and variable inflow; (2) evaluation of blade coupled elastic response due to these airloads; (3) modification of the airloads to include blade flexible motions. In the first phase, rotor airloads are evaluated numerically by describing blade motions with five degrees of blade freedom. Aerodynamic forces are obtained from strip theory by calculating local section angle of attack and by using this angle to evaluate force coefficients from tabulated data. The second phase is used to generate influence lines for the rotating blade. Coupled differential equations for combined flapwise bending, chordwise bending, and torsion are utilized for twisted nonuniform blades. In the third phase, blade elastic responses are used to evaluate corrected local section angles of attack to obtain new aerodynamic force coefficients. Final load distributions are integrated to yield rotor forces and performance. Dissert. Abstr.

**N69-13154*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
**PRELIMINARY INVESTIGATION OF DISTORTION DYNAMICS IN A MACH 3 MIXED COMPRESSION INLET**
Robert E. Coltrin and Glenn A. Mitchell Washington Dec. 1968 22 p refs
(NASA-TM-X-1706) Avail: CFSTI CSCL 01A

The inlet was operated at critical and supercritical conditions while at 0° angle of attack in the 10- by 10-foot supersonic wind tunnel. The cowl lip diameter was 45.98 cm. Total-pressure sensors with a flat response to 200 Hz were distributed at several diffuser exit locations. The amplitude probability density functions for the total pressures were nearly Gaussian. Frequency analysis showed that the amplitude of the power spectral densities for these pressures dropped by half from 0 to 100 Hz, but was nearly constant at higher frequencies. No periodic components were observed. Author

**N69-13216*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**AERODYNAMIC CHARACTERISTICS OF SPHERICALLY BLUNTED 45-DEG HALF-ANGLE CONES**
R. Passmanaeck 1 Sep. 1968 45 p refs
(Contract NAS7-100)
(NASA-CR-97894; JPL-TR-32-1327) Avail: CFSTI CSCL 01A

Pressure, force, and dynamic stability tests were conducted to compare theoretically calculated coefficients and pressure distribution to data obtained by experiment. The Newtonian theory has also been included for completeness. Comparisons are made for an ideal gas and a real gas in equilibrium. The dynamic stability test for the real gas was omitted because of tunnel limitations. Pressure distribution was also measured for a real gas in nonequilibrium. The models used were 45-deg cones of bluntness ratios, $R_N/R_B$ of 0, 0.25, 0.50, 0.75, and 1.00. Author

**N69-13218*#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
**HYPERSONIC AERODYNAMIC CHARACTERISTICS OF A MODEL OF A LOW-FINENESS-RATIO VARIABLE GEOMETRY LOGISTICS SPACECRAFT CONCEPT**
Bernard Spencer, Jr. Washington Dec. 1968 44 p refs
(NASA-TM-X-1701) Avail: CFSTI CSCL 01A

An investigation has been made in the Langley 15-inch hypersonic flow apparatus at a Mach number of 10.03 to determine the static aerodynamic characteristics of a model of a low fineness ratio variable geometry logistics spacecraft concept designed for

hypersonic lift drag ratios near 1.0. The variable geometry feature envisioned for the configuration is a fold-down-type wing, stowed in the triangular side areas of the body during entry and deployed at subsonic speeds for improvement in subsonic performance. The variable geometry feature is considered to be retracted for the present hypersonic tests. Author

**N69-13238*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**AN ESTIMATE OF THE SUPERSONIC FLOW FIELD ABOUT AN AXISYMMETRIC BODY WITH AN N WAVE PRESSURE TRACE**
Roger W. Luidens Washington Dec. 1968 28 p refs
(NASA-TN-D-4935) Avail: CFSTI CSCL 01A

Linearized flow assumptions and the conservation equations of mass, momentum, and energy are used to estimate the flow field at all distances from a body which produces an N wave pressure trace. The analytical results show good agreement with experimental results for cones and axisymmetric bodies with convex profiles. The influence of the shock wave entropy increase on the attenuation of the shock wave static pressure rise with distance from the body is illustrated. Author

**N69-13262*#** California Univ., Los Angeles. Dept. of Engineering.
**RAREFIED GAS FLOW OVER A SPHERE**
Takashi Sugimura Aug. 1968 177 p refs
(Grant NGL-05-007-003)
(NASA-CR-97869; REPT-68-32) Avail: CFSTI CSCL 01A

The problem of flow over a sphere is investigated within the framework of the kinetic theory of gases. Solutions are sought which describe the flow field for a large range of fluid densities. The governing equation for all density levels is the Boltzmann equation, which is an nonlinear integro differential equation. Instead of attempting to solve the Boltzmann equation exactly, one may be concerned primarily with certain mean quantities such as velocity, density, and pressure, but not the distribution function itself. One is then led to consider the moment equations of the Boltzmann equation or the Maxwell equation of transfer. The essence of the moment method consists in finding the unknown parametric functions introduced in the velocity distribution function. The present investigation for flow over a sphere is restricted to the two limiting cases; low speed flow, where the Mach number is very small, and the high speed approximation for very large Mach numbers. Author

**N69-13280#** National Physical Lab., Teddington (England). Aerodynamics Div.
**TWO TOPICS OF INTEREST IN EXPERIMENTAL INDUSTRIAL AERODYNAMICS. PART 1: APPLICATION OF MASKELL'S THEORY OF WIND-TUNNEL BLOCKAGE TO SOME LARGE SOLID MODELS. PART 2: DESIGN OF VELOCITY-PROFILE GRIDS**
C. F. Cowdrey Apr. 1968 15 p refs Presented at the Symp. on Wind Effects on Buildings and Struct., Loughborough, Engl., 2–4 Apr. 1968 Sponsored jointly by Loughborough Univ. of Technol., Natl. Phys. Lab. and Roy. Natl. Phys. Lab. and Roy. Aeron. Soc.
(NPL-AERO-1268) Avail: CFSTI

The theory of wind-tunnel blockage of bluff bodies, proposed by Maskell, is considered more generally and applied to a large solid model with a flat front surface nearly normal to the wind direction. In addition, a simple method is devised whereby the spacings of the rods of a velocity-profile grid can be quickly calculated. Author (ESRO)

**N69-13281#** National Physical Lab., Teddington (England). Aerodynamics Div.
**WIND TUNNEL TESTS ON CHIMNEYS OF CIRCULAR SECTION AT HIGH REYNOLDS NUMBERS**
R. W. F. Gould, W. G. Raymer, and P. J. Ponsford Apr. 1968 20 p refs Presented at the Symp. on Wind Effects on Buildings and Struct., Loughborough, Engl., 2–4 Apr. 1968 Sponsored jointly by Loughborough Univ. of Technol., Natl. Phys. Lab. and Roy. Aeron. Soc.
(NPL-AERO-1266) Avail: CFSTI

This report describes experiments intended to supply complete pressure distribution information for use in shell-stress computations for very large chimneys. Preliminary experiments were made to establish the conditions leading to the worst wind loading likely to be met in practice. Surface-flow studies were used to provide an understanding of the pressure-distributions measured. Author (ESRO)

**N69-13282#** National Physical Lab., Teddington (England). Aerodynamics Div.
**THE AERODYNAMIC INVESTIGATION FOR THE PROPOSED LOWER YARRA BRIDGE**
D. E. Walshe and N. Narita Feb. 1968 48 p refs
(NPL-AERO-SPECIAL-008) Avail: CFSTI

The sectional model method of test was used to improve the aerodynamic stability characteristics in smooth wind of a proposed design for a continuous deck box-stiffened cable-stayed bridge with overhung deck edges. The models of this type of construction were generaloy found to be subject to wind-excited oscillations of small amplitudes. Vortex generators promoted stability and fairing the edges of the box to meet the edges of the deck also improved the stability characteristics. Author (ESRO)

**N69-13283#** National Physical Lab., Teddington (England). Aerodynamics Div.
**THE AERODYNAMIC INVESTIGATION FOR THE PROPOSED ERSKINE BRIDGE**
D. E. Walshe Feb. 1968 30 p refs
(NPL-AERO-SPECIAL-007) Avail: CFSTI

Tests were made to determine the aerodynamic stability characteristics of a proposed design for a box-stiffened road deck of a cable-stayed bridge. The results indicate that the structure would undergo limited amplitude oscillations. Large-amplitude oscillations were observed only in high winds inclined upwards at 5 degrees to the horizontal. It was shown that modifications to the cross-sectional shape of the stiffening box could improve stability. Author (ESRO)

**N69-13365#** National Physical Lab., Teddington (England). Aerodynamics Div.
**AN AERODYNAMIC INVESTIGATION OF A MODEL OF THE PROPOSED SCAMMONDEN BRIDGE**
R. E. Whitbread and K. K. Gupta Mar. 1968 30 p refs
(NPL-AERO-SPECIAL-009) Avail: CFSTI

A wind-tunnel investigation has been carried out using a full aeroelastic model of a proposed motor vehicle bridge to determine the amplitude of oscillation likely to be induced by the natural wind. The investigation has shown that over the wind speed range 0-100 mph, the wind induced amplitudes will be well below the maximum level for human comfort for bridge vibration suggested by the Road Research Laboratory. Calculated values for the natural frequencies of oscillation were in good agreement with the values obtained from the model. Author (ESRO)

N69-13412# Aeronautical Research Council (Gt. Brit.).
**DRAG MEASUREMENTS ON A SERIES OF AFTERBODIES AT TRANSONIC SPEEDS SHOWING THE EFFECT OF STING INTERFERENCE**
A. G. Kurn 1968 47 p refs Supersedes RAE-TR-66298; ARC-28812; See N68-21783
(ARC-CP-984; RAE-TR-66298; ARC-28812) Avail: CFSTI

A number of axi-symmetric afterbodies consisting of the basic profile, a tangent ogive with a fineness ratio of 3.33, and progressively truncated versions of this shape were tested at zero incidence over a Mach number range from 0.6 to 1.3. Measurements were made of the afterbody pressure distribution, the base pressure and the total drag with and without the presence of various rear stings. In general the drag, in the absence of a sting, was increased by truncating the ogive, but at supersonic speeds small truncations had little effect. The results at a given free stream Mach number show that, for the different stings fitted to each afterbody, there is an approximately linear relationship between afterbody drag and base pressure. Curves are presented whereby the measured total drag of the sting-mounted afterbody model may be corrected to obtain the true total drag in the absence of the sting. Author (ESRO)

N69-13414# Aeronautical Research Council (Gt. Brit.).
**LOW-SPEED WIND-TUNNEL INVESTIGATION OF THE ROLL STABILITY OF 1/5 SCALE MODEL OF THE SHORT SC-1 AT LARGE SIDESLIP**
W. J. G. Trebble 1968 38 p ref Supersedes RAE-TR-67104; ARC-29420; See N68-13424
(ARC-CP-994; RAE-TR-67104; ARC-29420) Avail: CFSTI

In order to facilitate the study of the roll stability of V/STOL aircraft at large angles of sideslip, low speed wind-tunnel tests have been made on a 1/5 scale model of the Short SC 1. The results show that very large rolling moments can be produced if roll and sideslip are present together because of the lateral movement of the wing centre of pressure. This rolling problem is aggravated by a loss in aileron power as sideslip angle is increased. Recovery is feasible by turning into wind (reducing sideslip) and thus reducing the rolling moment to an acceptable level. Author (ESRO)

N69-13421# Aeronautical Research Council (Gt. Brit.).
**THE CALCULATION OF THE PRESSURE DISTRIBUTION ON A THICK CAMBERED AEROFOIL AT SUBSONIC SPEEDS INCLUDING THE EFFECTS OF THE BOUNDARY LAYER**
B. J. Powell Jun. 1967 32 p refs Supersedes NPL-AERO-1238; ARC-29300; See N68-24027
(ARC-CP-1005; NPL-AERO-1238; ARC-29300) Avail: CFSTI

A theory and a numerical technique are developed which can be used to predict the pressure distribution on a two-dimensional aerofoil at incidence in a subsonic viscous flow when the boundary layer displacement thickness on the aerofoil surface is known. A few examples are also included of calculated pressure distributions for which the boundary layer data was predicted theoretically. Author

N69-13475# Aeronautical Research Council (Gt. Brit.).
**MINIMUM DRAG SURFACES OF GIVEN LIFT WHICH SUPPORT TWO-DIMENSIONAL SUPERSONIC FLOW FIELDS**
J. Pike 1968 26 p refs Supersedes RAE-TR-66305; ARC-28825; See N67-35175
(ARC-RM-3543; RAE-TR-66305; ARC-28825) Avail: CFSTI

The two-dimensional surface giving minimum pressure drag for given lift coefficient in supersonic flow is considered. The method adopted is a small perturbation of a plane surface: the pressure is expressed as a power series in the perturbed slope and third order terms are neglected. The shape of the optimum surface is found to be a double wedge surface, with a single discontinuity in the surface slope. The compression surface is concave at the discontinuity for Mach numbers below about 1.4 and above 3, and between these it can be slightly convex. The performance in the case $\gamma = 1.4$ is compared with that of the plane wedge, and the improvement is found to be very small, except at hypersonic speeds when improvements greater than 1 per cent are obtained. Similar results hold for waveriders (three-dimensional wing shapes) based on two-dimensional flow fields. Author (ESRO)

N69-13487# Arbeitsgemeinschaft Satellitentraeger (ASAT), Munich (West Germany).
**STUDY ON THE SYSTEMATIC EVALUATION OF THE WOOMERA WIND PROFILES FOR THE PRELAUNCH-LOAD CHECK (PLC)**
H. Arens (Entwicklungsring Nord) 31 Aug. 1968 85 p refs (Contract ELDO/CTR-17/4/7)
Avail: CFSTI

The objective of the calculations performed in this study was to determine the uncertainty resulting from the time changes of the wind profiles for precalculation of the loads of Europa I launch vehicle at launching in Woomera (Australia). The variation of the loads is largely conditioned by the changes of the wind velocity at the critical altitude. ESRO

N69-13516# National Physical Lab., Teddington (England). Aerodynamics Div.
**SOME EFFECTS OF TURBULENCE OF THE FLOW AROUND BLUFF BODIES**
P. W. Bearman Apr. 1968 15 p refs Presented at the Symp. on Wind Effects on Buildings and Struct., Loughborough, Engl., 2–4 Apr. 1968 Sponsored jointly by Loughborough Univ. of Technol., Natl. Phys. Lab. and Roy. Aeron. Soc.
(NPL-AERO-1264) Avail: CFSTI

The effects of turbulence on the mean flow around flat and circular plates set normal to the flow, and a square prism are discussed. Spheres and circular cylinders in turbulent flow are also examined. In some instances it was found that the time-mean flow observed in turbulent flow could be significantly different from that observed in smooth flow. Author (ESRO)

N69-13522#
**ON THE THREE DIMENSIONAL BOUNDARY LAYER ON A BLUNT BODY**
N. D. Yvedenskaia [1968] 9 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekhan. Zhidk. i Gaza (USSR), no. 5, 1966 p 36–40
Avail: CFSTI

A solution to the Prandtl laminar boundary layer originating in the stationary flow at an angle of attack around a blunt cone is determined by the finite difference method. It was concluded that a smooth solution of the problem existed only in the neighborhood of the blunt bow of the body, while away from it the solutions acquired a singularity: there was a discontinuity in the first derivatives of the velocity components and the density in the plane of symmetry of the problem on the leeward side. An analysis of the numerical results showed that the properties of the solutions of the finite difference equation were not the results of numerical effects, but reflected the behavior of the solution of the differential equations. B.P.

N69-13621*# General Motors Corp., Indianapolis, Ind. Allison Div.
**EXPERIMENTAL INVESTIGATION OF ADVANCED CONCEPTS TO INCREASE TURBINE BLADE LOADING. 3: PERFORMANCE EVALUATION OF TANDEM ROTOR BLADE**

H. G. Lueders Washington NASA Dec. 1968 43 p refs
(Contract NAS3-7902)
(NASA-CR-1254) Avail: CFSTI CSCL 20D

The overall performance of a single-stage turbine designed with a tandem rotor blade and negative rotor hub reaction was investigated over a range of equivalent speeds and expansion ratios. Surveys of total pressure, flow angle, temperature, and hot-wire data were taken at the rotor trailing edge. The performance of the turbine is compared with the performance of a plain rotor blade turbine. Both turbines have the same design requirements and were tested with the same stator. Author

**N69-13625#** National Physical Lab., Teddington (England). Aerodynamics Div.
**ON THE INTRODUCTION OF TURBULENCE INTO WIND-TUNNEL INVESTIGATIONS FOR THE DETERMINATION OF WIND-INDUCED AMPLITUDES OF OSCILLATION**
R. E. Whitbread Apr. 1968 18 p refs Presented at the Symp. on Wind Effects on Buildings and Struct., Loughborough, Engl., 2–4 Apr. 1968 Sponsored jointly by Loughborough Univ. of Technol., Natl. Phys. Lab. and Roy. Aeron. Soc.
(NPL-AERO-1265) Avail: CFSTI

Measurements of the turbulence spectra obtained from two wind-tunnel investigations in which attempts were made to simulate atmospheric wind structure, are used to show that the scales of turbulence that can be generated by present techniques are generally too small to satisfy the linear scaling requirement for a particular investigation. A compromise procedure is suggested whereby the spectral density of turbulence over a significant range of wave number only is simulated. Author (ESRO)

**N69-13715#** Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
**AN INVESTIGATION OF THE DYNAMIC STABILITY CHARACTERISTICS OF A QUAD CONFIGURATION, DUCTED PROPELLER V/STOL MODEL. VOLUME 2, PHASE 2: LONGITUDINAL DYNAMICS AT HIGH DUCT INCIDENCE Final Data Report**
William F. Putnam, Joseph J. Traybar, Howard C. Curtiss, Jr., and John P. Kukon Ft. Eustis, Va. Army Aviation Mater. Labs. Aug. 1968 77 p refs
(Contract DAAJ02-67-C-0025)
(AD-676861; USAAVLABS-TR-68-49B; REPT-836) Avail: CFSTI CSCL 1/3

The results of experiments to determine the longitudinal dynamic stability characteristics of a quad configuration, ducted-propeller V/STOL aircraft at four low-speed/high-duct-incidence trim conditions (i sub d = 80, 70, 60, and 50 deg) are presented. Longitudinal transient responses in various degrees of freedom were measured using a dynamic model on the Princeton Dynamic Model Track. The data presented include time histories of the model motions in various longitudinal degrees of freedom that occur when the model is disturbed from trimmed flight. Responses are presented both with and without pitch rate feedback. The dynamic model employed in these experiments is a generalized research model arranged to represent closely the X-22A V/STOL aircraft. Author (TAB)

# 02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

**N69-12904** Aircraft Research Association, Ltd., Bedford (England).
**RECENT RESEARCH INTO SOME AERODYNAMIC DESIGN PROBLEMS OF SUBSONIC TRANSPORT AIRCRAFT**
A. B. Haines 1968 15 p refs Presented at 6th Cong. of the Intern. Council of the Aeron. Sci., Munich, 9–13 Sep. 1968
(ICAS-Paper-68-10; B-801) Avail: CFSTI

The aims and results of recent research into some design problems of subsonic transports are described. The emphasis is on how to obtain low drag in cruising flight and satisfactory buffet-free performance over the full flight envelope. In particular, how to design a three-dimensional wing to exploit recent advances in two-dimensional section design and how to devise satisfactory nacelle installations are discussed. The paper stresses the continuing need for research on the tunnel test techniques required to simulate flight behaviour, and to establish the exchange rates involved in design compromises between aerodynamic and other requirements. Author

**N69-12985** Pisa Univ. (Italy). Inst. of Aeronautics.
**RESEARCHES ABOUT THE USE OF STOL AIRCRAFT IN CIVIL TRANSPORT AVIATION: SOME EXPERIMENTAL RESULTS ON A STOL AIRCRAFT MODEL**
A. Salvetti 1968 21 p refs Presented at the 6th Congr. of the Intern. Council of the Aeron. Sci., Munich, 9–13 Sep. 1968
(ICAS-Paper-68-07; A-56) Avail: CFSTI

The technical economic evaluation of air transport over short hauls has been developed according to the following essential points: the prevision of the request of transport, the definition of the technical economic and operative characteristics of the aircraft STOL and VTOL which are suitable to satisfy the request of transport, the examination of the problem of inserting the airports for the aircraft STOL and VTOL into the urban centers they must serve, the economic evaluation of the system of air transport over short distances. A flying model of an aeroplane STOL with deflection of the slipstream and the boundary layer control has been realized, and will be used for trial flight. Author

**N69-13035** Lockheed-Georgia Co., Marietta.
**DAMAGE TOLERANCE AND LOGISTIC TRANSPORT DESIGN**
W. T. Shuler 1968 14 p refs Presented at 6th Cong. of the Intern. Council of the Aeron. Sci., Munich, 9–13 Sep. 1968
(ICAS-Paper-68-23; F-232) Avail: CFSTI

Several examples from operational experiences with military and commercial transport aircraft are illustrated and briefly discussed. The incorporation of damage tolerance levels in the design of structures of the following aircraft is outlined: C-130 turboprop assault transport; C-140 jet executive transport; C-141 jet medium logistics transport; and C-5A jet heavy logistics transport. For these aircraft, a type of damage is assumed and related to the fuselage pressure cabin, the wing box structure, the horizontal and vertical stabilizer box structure, the control surfaces, the control systems, and the auxiliary control devices. Analytical and test methods for determining the existence of desired tolerance levels are indicated. The use of damage-tolerant structures and devices is discussed, including positive crack stops, alternate paths, joints with bearing critical fasteners, and fail-safe titanium straps. The effects of these design measures on airframe costs, weight, reliability, and maintainability are considered. K.W.

**N69-13185*#** Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
**SYNTHESIS METHODS FOR MANUAL AEROSPACE CONTROL SYSTEMS WITH APPLICATIONS TO SST DESIGN**
Walter W. Wierwille and James R. Knight Washington NASA Dec. 1968 144 p refs
(Contract NAS1-7141)
(NASA-CR-1208; CAL-IM-2429-B-1) Avail: CFSTI CSCL 01D

Two synthesis approaches were studied: a programming approach and a man-machine performance approach. The programming approach places emphasis on moving the poles or eigenvalues of a closed-loop flight control system toward positions considered most desirable from a handling qualities point of view. These poles or eigenvalues are functions of each adjustable parameter in the compensators and various sensor feedback paths. To adjust the various parameters optimally, a programming procedure was developed that was implemented by means of digital computer programs. Three programs have been developed. The first performs synthesis in a single flight regime, determining optimum fixed values for the adjustable parameters. The second performs synthesis in an arbitrary number of flight regimes simultaneously, again determining a single set of fixed values for the adjustable parameters. The third program also performs synthesis in an arbitrary number of flight regimes simultaneously, but allows specified parameters to vary from one regime to another. The programming approach was applied to the longitudinal dynamics of an SST for six flight regimes. It was found that all three programs operated effectively in moving the closed-loop system poles. Author

**N69-13252*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**FLIGHT TESTS UNDER IFR WITH AN STOL TRANSPORT AIRCRAFT**

Robert C. Innis, Curt A. Holzhauser, and Richard P. Gallant Washington Dec. 1968 65 p refs

(NASA-TN-D-4939) Avail: CFSTI CSCL 01B

An STOL transport was studied in instrument flight. This aircraft was flown on 7-1/2° and 2-1/2° ILS approaches. It could be flown comfortably and accurately on the 7-1/2° ILS at 60 knots to 200 feet above the runway. The descent and deceleration capabilities were more than adequate in the approach and landing configuration, but were not sufficient in the preapproach configuration. The handling characteristics during instrument flight were generally satisfactory, except for moderate heading excursions at low speeds and moderate angle-of-attack excursions at the rear center of gravity. These characteristics, while not satisfactory, were acceptable and are considered general problems of STOL aircraft operations. Author

**N69-13259*#** San Diego Aircraft Engineering, Inc., Calif.

**POTENTIAL STRUCTURAL MATERIALS AND DESIGN CONCEPTS FOR LIGHT AIRPLANES**

L. Pazmany, H. Prentice, C. Waterman, and F. Tietge Oct. 1968 35 p

(Contract NAS2-4423)

(NASA-CR-73257) Avail: CFSTI CSCL 01C

The potential design considerations for light airplanes and helicopters include weight, crashworthiness, cost and mass production, and performance. Potential materials, fatigue evaluation, fastening methods and applications are discussed. Among the conclusions are the following: More sophisticated techniques are used in helicopter than in light aircraft construction. Aluminum sheet metal airframe will continue to be used. Relatively new alloys can replace most of the skin material with resultant cost savings. Riveting is still the easiest, cheapest, and most inspectable way of joining metals. Metal bonding will be increasingly used. The use of fiberglass prepreg laminates and ultraviolet curing appears promising. Nylon matrices reinforced with chopped glass, glass fiber reinforced epoxy system, and graphite fiber reinforced plastics are expected to be inexpensive structural materials. The cost of a reinforced plastic plane 15 years hence is expected to be half of the present day plane. N.E.N.

**N69-13368#** Aeronautical Research Council (Gt. Brit.)

**LOW-SPEED WIND-TUNNEL TESTS ON A 1/8 SCALE MODEL OF AN AIR-CUSHION-VEHICLE (BRITTEN-NORMAN CUSHIONCRAFT C.C.2)**

W. J. G. Trebble 1968 65 p refs Supersedes RAE-TR-66383; ARC-29280; See N68-12991

(ARC-CP-983; RAE-TR-66383; ARC-29280) Avail: CFSTI

An investigation has been made into the effects of mainstream speed on the performance and stability of a model of an air cushion vehicle. At constant speed of the lifting fan, the lift increases both with reduction in ground clearance and increase in forward speed. The craft has a large drag which is mainly intake momentum drag. Limited speed could be available from tilting the craft bows down, but augmentation from propulsive units would be required for higher speeds. Large nose-up moments occur at forward speed, reaching a maximum when the mainstream dynamic head is comparable with the cushion pressure. At higher speeds, the front air curtain breaks down with a resultant rearward movement of the centre of cushion lift thus giving some reduction in the nose-up moment. Pitch stiffness is reduced by an increase in either ground clearance or speed and is reduced to zero when the front curtain breaks down; at higher speeds there is some recovery in stability. Attempts to improve pitch control by means of a tailplane or by throttling the front jet proved inadequate. Author

**N69-13410#** Aeronautical Research Council (Gt. Brit.)

**A NOTE ON SOME STATIC TESTS OF FLEXIBLE SKIRTS FOR HOVERCRAFT**

W. G. S. Lester and F. T. Kiernan 1968 39 p ref Supersedes RAE-TR-66053; ARC-29356; See N68-13139

(ARC-CP-990; RAE-TR-66053; ARC-29356) Avail: CFSTI

A series of static tests conducted to establish an efficient form of flexible skirt for a peripheral jet type of hovercraft is reported. The importance of designing the peripheral jet system in conjunction with the skirt is demonstrated. The results suggest that the effective width of a flexible nozzle is less than its actual width and the discharge coefficient requires determining experimentally for each configuration. It is concluded that skirt configuration performance is best compared on the basis of power input to a skirt to generate a given cushion pressure for a specified daylight clearance. The results confirm that the skirt input power per unit exit area, based on daylight clearance and jet length, is directly proportional to (cushion pressure)$^{3/2}$. Author (ESRO)

**N69-13439#** Ryan Aeronautical Co., San Diego, Calif.

**XV-5A AERODYNAMIC-PROPULSION DATA CORRELATION AND CHARACTERISTICS DEVELOPMENT BASED ON WIND TUNNEL CHARACTERISTICS Final Report**

William C. Parks, Robert L. Swingle, and William C. Swope Jul. 1968 257 p refs

(Contract DA-44-177-AMC-456(T))

(AD-678862; USAAVLABS-TR-67-75; REPT-29467-1) Avail: CFSTI CSCL 1/3

The report presents the results of efforts to correlate data for the XV-5A V/STOL aircraft configuration, including small-scale and full-scale wind tunnel investigations and wind tunnel and thrust stand tests of the actual aircraft. The majority of the data correlation work was performed utilizing results from 1/6-scale and full-scale model tests which were conducted during the period of aircraft development. Correlation was limited primarily to wing-body characteristics. Corrections for configuration differences were developed, and the effects of dynamic dissimilarity of the fan systems were evaluated in the data comparison effort. Wind tunnel wall corrections were applied to the full-scale data. Author (TAB)

N69-13514# Centre National de la Recherche Scientifique, Marseilles (France). Lab. d'Astronomie Spatiale.
**GENERALITIES ON BALLOON EXPERIMENTS [GENERALITES SUR LES EXPERIENCES BALLON]**
B. Authier and J. Raynard 1967 25 p In FRENCH
(Rapt-67-Tech-01) Avail: CFSTI

Different components of French balloon experiments are described. The altitude control system of the measurement platform based on star sensors is considered and pre-launch operations described. ESRO

N69-13573# Federal Aviation Administration, Washington, D. C. Flight Standards Service.
**EVALUATION OF HELICOPTER STEEP SLOPE GCA OPERATIONS**
Allan W. Hunting and Russell S. Fleming May 1968 69 p refs
(AD-676528) Avail: CFSTI CSCL 1/2

The purpose of the study was to evaluate steep approaches flown in helicopters used for training and tactical operations, and to record data for use in the development of precision approach procedures for rotary wing aircraft. These data can also be applied to civil procedures standards and common system approach facilities. In this evaluation the following factors were considered: (a) Flyability of glide slope angles chosen; (b) Airspeed/vertical velocity envelopes; (c) Lengths of instrument approach segments; (d) Location of ground point of intercept (GPI); (e) Deceleration distances; (f) Decision height; (g) Required obstruction clearance (ROC); (h) Lead fix requirements; (i) Exposure time from decision height (DH) to touchdown; (j) Deceleration during the descent; (k) GCA procedure techniques; (l) GCA antenna alignment changes in azimuth and elevation; (m) Comparison between stabilized and unstabilized helicopters. The maximum usable effective angle was found to be 12 degrees. The flight parameters, approach procedure, and obstacle clearance requirements appropriate to steep approach angles were derived for application to Army training and tactical use. Conclusions and recommendations of particular relevance to civil procedures are noted. Author (TAB)

N69-13747# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**REFINEMENT OF AIRCRAFT ASSEMBLY TECHNIQUE. PART 3**
Chen-Wen Wu 25 Oct. 1967 8 p Transl. into ENGLISH from Hang K'ung Chih Shih (Chinese People's Rep.), no. 4, 1965 p 11
(AD-676266; FTD-HT-67-142) Avail: CFSTI CSCL 1/3

The over-all assembly of an airplane is the most important final step in the process of manufacturing airplanes. Recently, in order to increase the aircraft production rate and shorten the period of production, many people have developed several methods. Many new techniques have been introduced into aircraft final assembly work. This is reflected in the extensive application of electronic equipment and other special devices and also electronic test instruments. In the area of industrial technology, most countries have been devoting their efforts to increasing production tempo and lowering of production time. Basically, this involves the following characteristics: a large amount of airplane assembly work divided into several stages and completed independently; improvement of mechanization and standardization of equipment in final aircraft assembly plants; and complex testing techniques. TAB

N69-13841*# San Diego Aircraft Engineering, Inc., Calif.
**POTENTIAL STRUCTURAL MATERIALS AND DESIGN CONCEPTS FOR LIGHT AIRPLANES Final Report**
L. Pazmany, H. Prentice, C. Waterman, and F. Tietge Oct. 1968 374 p refs
(Contract NAS2-4423)
(NASA-CR-73258) Avail: CFSTI CSCL 01C

The primary objectives of this study are: (1) to evaluate materials and structural concepts presently and potentially available for light aircraft construction by investigating design, manufacturing, operational, and material requirements in terms of costs; (2) to apply promising materials and structural concepts to light aircraft design; and (3) to identify problem areas where additional research may increase the potential of promising materials on concepts. Two levels of technology and two types of light aircraft, fixed and rotary wing, were considered. The levels of technology were "near term", 5 years hence, and "far term", 15 years hence. The first phase of the study was concerned with evaluating available information on operational characteristics, material properties, structural concepts, manufacturing, and cost considerations. During the second phase the promising structural materials and concepts were selected and then applied to the two conceptual designs for the two technology levels. Early results indicated that the economic gains would be more significant for "far term" aircraft, that light fixed wing and light helicopter structures are similar, and that the fabrication cost of the selected materials and concepts needed further analysis. The stress of the study is therefore on the "far term" light airplane. K.W.

# 03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N69-12616 Washington State Univ., Pullman.
**THE INTERACTION OF POLARIZED INFRARED RADIATION WITH SOLID MATERIALS**
Frederick Herman Carl Schultz (Ph.D. Thesis) 1967 97 p
Avail: Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 68-717

An apparatus was constructed to constantly measure the response of a photoconductive cell while changing the angle of incidence of chopped, polarized, infrared radiation through 180°. Responses were recorded for twenty different lead sulfide cells for 1.47, 2.00, and 2.50 $\mu$ wavelength radiation polarized parallel to and normal to the plane of incidence. Calculations were made and computer programmed to give the theoretical response of cells of various constructions to polarized radiation at angles of incidence varying in 1° steps from 1° to 89°. The actual cell responses were compared to the theoretical. Calculations were made and computer programmed to calculate the complex optical constants n and k, for the lead sulfide of a cell, from the ratios of the response to radiation polarized normal to the plane of incidence to that polarized parallel to the same plane at several different angles of incidence. Dissert. Abstr.

N69-12833*# TRW Systems Group, Redondo Beach, Calif.
**A STUDY OF THE STATE OF THE ART OF HERMETIC SEALS FOR SECONDARY ALKALINE SPACECRAFT CELLS Final Report, 20 Jun. 1967–20 Mar. 1968**
W. R. Scott, Jr. Mar. 1968 98 p refs
(Contract NAS5-10432)
(NASA-CR-97888; TRW-09299-6001-R0-00) Avail: CFSTI CSCL 10C

A study was conducted of the current state of the art of hermetic seals for secondary alkaline spacecraft battery cells, including seals now in use, those under development, and those potentially useful. Manufacturing, test, analysis, and performance

data from the space field were collected and analyzed with the objectives of determining the degree to which existing seals satisfy current and future requirements, of identifying any deficiencies, and of providing guidelines for future seal research and development work that may be indicated. All known types of hermetic seals were reviewed for their applicability to alkaline cells and for a background for the study. Cell vendors, users, and test organizations were surveyed by questionnaire and most of them were subsequently interviewed. Author

**N69-12912#** California Univ., Berkeley. Lawrence Radiation Lab.
**AN EXAMINATION OF A LIQUID HELIUM REFRIGERATION SYSTEM FOR SUPERCONDUCTING MAGNETS IN THE 200 GEV EXPERIMENTAL AREA**
Michael A. Green, Gordon P. Coombs, and James Perry 11 Jul. 1968 19 p refs Presented at the Conf. on Superconducting Devices and Accelerators, Upton, N. Y., 10 Jun.–16 Jul. 1968
(Contract W-7405-ENG-48)
(UCRL-18188; CONF-680621-4) Avail: CFSTI

A summary is presented of a study of refrigeration of superconducting magnets in a 200-GeV accelerator. A model of the proposed 200-GeV experimental area is presented, and several 4.2°K helium refrigeration systems and their costs are analyzed. NSA

**N69-12971#** Aerospace Corp., El Segundo, Calif. Laboratory Operations.
**INTERNAL HEAT LOSSES AND ALTERNATIVE CONFIGURATIONS FOR A LIQUID-PISTON TWO-PHASE HEAT ENGINE**
K. E. Starner and W. E. Welsh, Jr. 15 Oct. 1968 53 p
(ATR-69(8123)-1) Avail: Issuing Activity

A heat engine based on the concept of the toy drinking bird that might be used to power irrigation equipment in underdeveloped countries is considered. A previous report by Welsh and Starner presented analytical and experimental results of a thermodynamic study of such liquid-piston engines. This report presents experimental results of a study of an alternative concept based on a symmetrical design. It is shown, and experimentally verified, that in the absence of heat losses from unwanted internal condensation, symmetrical devices offer cost and weight advantages of a factor of 2 to 4 over asymmetrical devices. An internal heat loss analysis with emphasis on liquid interface condensation is performed to provide guidelines for future design. It is also shown, and experimentally verified, that factors such as construction materials, fluid selection, and system configuration are important in maintaining these heat losses within tolerable limits. The effect of transfer tube size (length and diameter) on thermal efficiency is investigated. Finally, a solid-piston type symmetrical device is suggested to eliminate condensate losses to the liquid interface and to achieve higher power-to-weight ratio. Author

**N69-12989*** Gulf General Atomic, San Diego, Calif.
**LONG TERM OPERATIONS OF IN-PILE AND OUT-OF-PILE THERMIONIC CONVERTERS, PARTS 1 AND 2**
J. W. Holland, M. K. Yates, D. E. Schwerzer, and J. Kay 10 Jun. 1968 22 p refs Presented at 2d Intern. Conf. on the Thermionic Elec. Power Generation, Stresa, Italy, 27–31 May 1968
(Contracts NAS3-8504; AT(04-3)-167)
(NASA-CR-97870; GA-8900) Avail: CFSTI CSCL 10B

I. Ten cylindrical geometry converters with series designation Mark VI were life tested in-pile for a total of 20,034 hours, an average life of 2003 hours, and an average electrode power density of 7.2 W/cm$^2$. The longest test to date ran for 5369 hours at an average electrode power density of 10 W/cm$^2$. That test designated as IC-15 was fueled with $UO_2$ and achieved a burnup of 2 × $10^{20}$ fission/cm$^3$. II. Out-of-pile models of the Mark VI converters were life tested for a total of 51,542 hours, an average life of 6443 hours and an average power density of 7.9 W/cm$^2$. The longest test to date ran 10,406 hours at an average electrode power density of 8.6 W/cm$^2$. Both unfueled and fueled versions were tested. Author (NSA)

**N69-13030*#** General Electric Co., Schenectady, N. Y. Research and Development Center.
**STUDY OF MULTIPLE RESERVE ELECTROCHEMICAL POWER SOURCES Final Report**
W. N. Carson, Jr. and H. A. Christopher Aug. 1968 70 p
(Contract NAS7-674)
(NASA-CR-97858; S-68-1165) Avail: CFSTI CSCL 10C

The analysis of three high-energy density galvanic cell systems showed that multiple activation of a single large battery is not a useful approach. The general design most suitable for a multiple reserve power supply in a single package calls for seperate activation of each section. The lithium–cupric sulfide cell employs a nonaqueous electrolyte. The lithium–selenium cell is a high-temperature cell, using a molten salt electrolyte. The metal–oxygen cell study was restricted to zinc and aluminum as anodes. The lithium–selenium system offers the most promise. This system is activated by heating to the operating temperature of 375°C. A boron–vanadium pentoxide mix delivering 750 calories per gram at 375° C was used as the heat source material. Typical energy densities were over 190 watthours per pound, ranging to 270 watthours per pound for favorable missions. The analysis for the metal–oxygen systems favors zinc as the anode metal; the energy densities range from 40 to 50 watthours per pound to 160 to 170 watthours per pound. The lithium–cupric sulfide system employing a tetrahydrofuran–lithium perchlorate electrolyte energy energy density values of 2.8 to 150 watthours per pound. Author

**N69-13045*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**RESULTS OF RESEARCH ON A SINGLE-COMPONENT SYSTEM FOR A LIQUID-METAL MHD CONVERTER**
B. G. Bogomolv et al 1968 21 p refs Transl. into ENGLISH from Russian Conf. paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97883; SM-107/135) Avail: CFSTI CSCL 10B

Problems in designing single-component closed loop MHD converter using potassium are discussed. The thermodynamic cycle is analyzed, and the two-phase nozzle design is discussed which is dependent on a semi-empirical method. Studies were made of the mixing chamber using a monojet and water, and observations were made by sampling the flow pressure and temperature, visually and with photographs and oscillographs. The effects of injection speed, vapor dryness, vapor temperature, and other parameters on operation of the MHD converter were investigated. The closed flow system is shown to be easily controlled and to be stable, and the effect of the change in power fed to the steam generator on flow pattern is described. N.E.N.

**N69-13067*#** Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
**PARALLEL OPERATION OF STATIC INVERTERS AND CONVERTERS AND EVALUATION OF MAGNETIC MATERIALS**
C. L. Doughmen Aug. 1968 32 p refs
(Contract NAS3-2792)
(NASA-CR-72455; WAED-68.73E) Avail: CFSTI CSCL 10B

A summary is presented on the design, analysis, and development work of four other reports relating to the ability to operate static inverters or converters as parallel electric power

systems. In addition, data on several magnetic materials are generated for square-wave excitation at frequencies ranging from 400- to 3200-Hz. Areas described are the analysis and design of load-division circuits for inverters and converters, the establishment of automatic control and protection philosophy and circuits, the development of static-power contactors, and the initial study of load programming as a means of improving load capacity of parallel electric power systems. Author

N69-13058*# Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
**LOAD PROGRAMMER, STATIC SWITCHES, AND ANNUNCIATOR FOR INVERTERS AND CONVERTERS**
R. W. Briggs, C. L. Doughman, R. D. Jesse, and E. F. Swiderski Jan. 1968 115 p refs
(Contract NAS3-2792)
(NASA-CR-72454; WAED-68.36E) Avail: CFSTI CSCL 09E

A load programmer concept developed for an electric power system compares system capacity to load demand and, as required, automatically removes lower-priority loads. Characteristics and experimental test results of a three-phase static switch and a dc switch are analyzed. Circuit interruption times of less than three milliseconds are obtained for current loads up to 250 percent of rated value. An annunciator developed to operate in conjunction with the control and protection circuits visually displays the state of either a dc or an ac system consisting of multiple paralleled converters or inverters. Author

N69-13084*# Monsanto Research Corp., Everett, Mass. Boston Lab.
**SEPARATOR DEVELOPMENT FOR A HEAT STERILIZABLE BATTERY Final Summary Progress Report Supplement, 12 Jul. 1967–12 Jun. 1968**
John J. O'Connell, Elizabeth A. McElhill, and Carl A. Olson 12 Jun. 1968 48 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951524)
(NASA-CR-97900; MRB6234FS) Avail: CFSTI CSCL 10C

Two ligand–containing polymers were developed as separator materials for heat sterilizable silver oxide–zinc cells. A pilot film sample was derived from a 33:67 2-vinylpyridine:methyl methacrylate copolymer. The sample consists of a total of 150 square feet, in sections over 10 feet long, of 1.5 mil film which as 7000 psi dry tensile strength and shows electrical resistivity under 10 ohm-in. after sterilization in 40% KOH at 135°C. The film normally requires about 120 hours sterilization to reach this minimum resistance, but pretreatment with alcohols shortens the time to under 64 hours. The second polymer is a tetrapolymer made from an 18–29:9:44 styrene: maleic anhydride: methyl methacrylate: methly acrylate monomer charge that is crosslinked during film formation by reaction with a diamine. Films of this material with 1 to 2 mil thickness have dry tensile strengths of about 8000 psi and reach electrical resistivities of about 20 ohm-in. after sterilization for 64 hours. Author

N69-13150*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**END EFFECT IN MHD DUCTS WITH NON-CONDUCTING PARTITIONS**
I. V. Labventyev 1968 10 p refs Transl. into ENGLISH from Russian Conf. Paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97886; SM-107/137) Avail: CFSTI CSCL 10B

The effect of introducing a nonconducting partition into the end zone of a magnetohydrodynamic duct is evaluated where the plane of the partition is parallel to the induction vectors of the magnetic field and the velocity of the fluid. Solutions are obtained for partitions of both infinite and finite length. A.C.R.

N69-13151*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**THERMODYNAMIC ANALYSIS OF NEW CYCLES FOR LIQUID-METAL MHD GENERATORS**
V. M. Boldyrev et al 1968 11 p refs Transl. into ENGLISH from Russian Conf. Paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97885; SM-107/142) Avail: CFSTI CSCL 10B

The problem of creating an acceleration device for an efficient liquid metal magnetohydrodynamic power plant is examined on the basis of separator and injector variants. Low internal efficiencies for the injector variant due to shock losses were analyzed, and literature advocating the use of a multistage injector cycle to eliminate the losses was reviewed. It is concluded that such a cycle will operate efficiently only after losses due to irreversible mixing of flows with substantially different temperatures are eliminated as well as those due to shock. Suggestions are made for the improvement of the thermodynamic multistage cycles with regeneration as related to three variants: a multistage separator plant with regenerative preheaters; a multistage injector plant with condensation of the vapor phase at optimum vapor and liquid velocities; and a multistage injector-separator plant using wet metal vapor. A.C.R.

N69-13225*# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
**SEPARATOR DEVELOPMENT FOR A HEAT STERILIZABLE BATTERY**
L. C. Scala and G. D. Dixon 31 Jul. 1968 11 p Prepared for JPL
(Contracts NAS7-100; JPL-951525)
(NASA-CR-97905; QR-8) Avail: CFSTI CSCL 10C

It is now possible continuously to dip-coat Webril support tape which is 12 inches wide. Long runs have been made producing separator material having satisfactory resistivity values and hydroxyl ion diffusion rates. Several alternative supporting tapes have been evaluated. Flame absorption spectroscopic analysis indicated that zincate ion diffusion was very slow. The addition of free zirconia to the sterilizing mixture reduced the weight loss and decreased the resistivity of most separators. Author

N69-13228*# Ryan Aeronautical Co., San Diego, Calif. Electronic and Space Systems.
**DEPLOYABLE LARGE AREA SOLAR CELL ARRAY TESTING**
15 Aug. 1968 221 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951107)
(NASA-CR-97904; REPT-20869-4) Avail: CFSTI CSCL 10B

Results of testing and evaluation of a prototype large area rollup solar array structure are presented. The 50-square foot solar panel was designed as one element of a 200-square foot four-panel array of silicon solar cells suitable for a hypothetical Mars or Venus mission using chemical systems and an Atlas/Centaur launch vehicle. Environmental test conducted include deployment cycling in a 1.0g field, launch vibration, deployment in vacuum in earth shadow, deployment and retraction sun-oriented near Earth and near Venus, cruise maneuver acceleration loads, and deployed dynamics characteristics. Performance of the array in each environment is evaluated and conclusions with respect to detail design features are presented. Author

N69-13234*# Boeing Co., Seattle, Wash. Space Div.
**LARGE AREA SOLAR ARRAY, PHASE 2 Final Report**

J. L. Apperson, F. W. McAfee, D. A. Norsen, and R. C. Weikel Oct. 1968 271 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951934)
(NASA-CR-97868; D2-113355-7) Avail: CFSTI CSCL 10B

This is the large area solar array, Phase 2, final report. Phase 2 is the second step in the large area solar array program and further develops fabrication procedures and design of a 1,250-square-foot section of the large area solar array. The results of this effort include: (1) the activity and results of the development testing of mechanism components for tiedown, release, and deployment of the array; (2) the fabrication methods and test activity and results for the 8- by 13-foot main subpanel; (3) the development, test and analyses of the simulated zero g deployment fixture, and the deployment testing with full-scale dummy subpanel and prototype deployment mechanisms; (4) the preliminary design for Phase 3 GSE; (5) the production and usage of transportation handling and test equipment; (6) the development of deployment demonstration equipment; and (7) the electrical degradation and vibration tests and analyses of a 4-foot-square sample panel. Author

**N69-13240*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**THE EFFECTIVE ELECTRICAL CONDUCTIVITY OF A TWO-PHASE LIQUID-METAL FLOW**
N. D. Gavrilova, L. D. Dodonov, and I. T. Aladyev 1968 6 p refs Transl. into ENGLISH from the Russian Conf. Paper Presented at the Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97872; SM-107/153) Avail: CFSTI CSCL 10B

The hydrodynamics of a two phase vapor potassium flow for MHD generation of electric power are studied by comparing experimental results on two-phase flow conductivities. It is shown that the pondermotive forces in the two-phase flow, acting basically on the liquid metal, increase the slippage of the phases and the carrying away of the liquid from the boundary layer film to the vapor nucleus of the flow increases in the diffuse-annular structure; at the same time the conductivity of the flow decreases. G.G.

**N69-13246*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**EVALUATION OF A FLUIDIC OSCILLATOR AS A MOLECULAR WEIGHT SENSOR FOR GAS MIXTURES**
Milton J. LeRoy, Jr. Washington Dec. 1968 15 p refs
(NASA-TM-X-1698) Avail: CFSTI CSCL 10B

A fluidic oscillator was tested to determine its performance as a molecular-weight sensor for flowing gas mixtures. A linear relation between inverse frequency squared and molecular weight was obtained over the test range. It was also determined that the temperature of the gas and pressure drop across the oscillator must be kept constant. Author

**N69-13254*#** Oak Ridge National Lab., Tenn. Reactor Div.
**DESIGN OF BOILER-SUPERHEATER UNITS FOR REPRESENTATIVE CESIUM AND POTASSIUM SPACE POWER PLANTS**
T. T. Robin Sep. 1968 91 p refs
(NASA Order W-12353; Contract W-7405-eng-26)
(NASA-CR-97994; ORNL-TM-2080) Avail: CFSTI CSCL 10B

Boiler designs were developed for both potassium and cesium systems. Two design approaches were used. The first was based on using vortex generator inserts to centrifuge droplets to the walls and thus improve heat transfer in the transition region. The second was directed toward design for low-liquid entrainment in the boiling region. The results indicate that the cesium boiler is heavier than the potassium boiler by a factor of 1.3 for the vortex generator approach, and by a factor of 2.7 for the low-liquid entrainment approach. Further, it appears that the low-liquid entrainment approach yields boilers that are smaller by a factor of about 3 to 5 and lighter by a factor of about 2 for potassium; for cesium the weight saving from use of the low entrainment approach appears to be only about 20%. Author

**N69-13286*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**EXPERIMENTAL INVESTIGATION OF AN INJECTOR DEVICE**
V. S. Danilian et al 1968 9 p refs Transl. into ENGLISH from Russian conf. paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97870; SM-107/143) Avail: CFSTI CSCL 10B

The basic purpose of the work is to study the features of the characteristics [i.e. performance] of an injector using wet steam [vapor]. These investigations are of interest in connection with the fact that thermodynamic analysis shows that the optimum efficiency cycles of liquid-metal MHD plants [installations] must be accomplished on fairly wet steam. The operation of a wet steam injector along with the mixing chamber and diffuser [exit cone] includes the necessity of studying the operation of the steam [vapor] nozzle. This study is suitable both for conducting the study on a nozzle alone and on a nozzle coupled with the mixing chamber of the injector. Author

**N69-13287*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**INVESTIGATION OF TWO-PHASE LAVAL NOZZLES**
I. T. Alad'yev et al 1968 7 p refs Transl. into ENGLISH from Russian conf. paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97877; SM-107/158) Avail: CFSTI CSCL 10B

A two-phase supersonic nozzle is an essential element of any liquid-metal MHD-generator scheme. At the present time there is no strict theory for such a nozzle, and existing methods for approximation calculations are based on many simplifications the validity of which are not at all clear. On the other hand, experimental investigations of two-phase nozzles are extremely limited and, in addition, contain information pertaining to a particular case. The accumulation of experimental data on two-phase nozzles, at the present stage, is an important problem. Some results of the experimental investigation of two-phase nozzles completed in a Heat Exchange Laboratory are presented. Author

**N69-13288*** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**EXPERIMENTAL INVESTIGATIONS ON LIQUID-METAL MHD GENERATORS**
G. A. Baranov et al 30 Jul. 1968 10 p refs Transl. into ENGLISH from Russian conf. paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97879; SM-107/136) Avail: CFSTI CSCL 10B

MHD generators due to the large velocities of the liquid-metal working medium have hydraulic losses in the ducts that comprise a considerable part in the total balance of power. The tendency has been noted to decrease the length of the operating ducts of the generators. However, end effects begin to appear associated with the openness of the magnetic system of linear generators, which leads to a sharp deterioration in their operating performance [characteristics]. A number of known methods of improving the performance of short generators are based on the equilization of the magnetic field in the gap along the duct and in the correct field

shaping in the input and output zones of the working medium into the field. These questions were experimentally investigated on plane AC and DC linear generators. Work was performed in the selection of optimal duct geometry from the point of view of reducing their hydraulic resistance, and generators of the helical type were investigated where the end effects appear considerably weaker. Author

N69-13310*# Aeronutronic, Newport Beach, Calif.
**NEW FUNCTIONAL REDUNDANCY APPROACHES FOR ATTITUDE CONTROL THRUSTER SYSTEMS**
C. E. Hallum and P. W. Webster Jul. 1968 134 p refs
(Contract NAS2-3664)
(NASA-CR-73231) Avail: CFSTI CSCL 22C

The inert gas thruster system study program was to survey, study, conceive, investigate and demonstrate new components and systems which would provide improved system reliability and have potential performance improvements. The program was initially directed to study improved thruster valve concepts. It was also considered desirable for the proposed improvements to be applicable to either of two specific spacecraft (Bios and Pioneer). Subsequently the program was redirected to study new approaches to inert gas thruster systems. New component and thruster system functional approaches were studied and preliminary designs of two systems for both the Biosatellite and Pioneer were prepared and presented to NASA ARC. The Pioneer multi-tank thruster system was selected for further evaluation. Critical elements of the selected system have been designed, fabricated and tested. Author

N69-13314# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INTERNATIONAL SYMPOSIUM ON PRODUCTION OF ELECTRIC POWER BY MEANS OF MHD GENERATORS (SELECTED ARTICLES)**
14 Nov. 1968 551 p refs Transl of the book "Mezhdunarodnyy Simpozium Po Proizvodstuv Elektroenergii S Pomoshch'yu MGD Generatorov" 1965 p 1–481 Meeting Held at Salzburg, Austria, 4–8 Jul. 1966 Sponsored by Inter. Atomic Energy Agency and EURATOM
(AD-674611; FTD-HT-67-195) Avail: CFSTI CSCL 10/2

A compilation of articles on the research, development, and operation of magnetohydrodynamic generators used for electrical energy production are presented. Related papers on such topics as superconducting magnet systems and the chemistry of various metal compounds are included. For individual titles see N69-13315–N69-13354.

N69-13315# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**STUDIES OF ELECTRODES IN AN MHD GENERATOR [ISSLEDOVANIYE ELEKTRODOV V MHD GENERATORE]**
V. C. Bzhozovski et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 1–10 refs (See N69-13314 03-03)
(SM-74/62) Avail: CFSTI

Four different types of ceramic and metallic electrodes were studied in an MHD generator. Experiments were made on temperature of electrodes, their stability and erosion. Author

N69-13317# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**A METHOD OF OPTIMIZATION OF THE CONSTANT CURRENT ELECTROMAGNET IN AN MHD GENERATOR [METODIKA OPTIMIZATSII ELEKTROMAGNITA MGD GENERATORA POSTOYANNOGO TOKA]**
Iosef Shenk *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 26–43 refs (See N69-13314 03-03)
(SM-74/83) Avail: CFSTI

The dependence of the specific computed costs and of the specific power of the electromagnet on the magnitudes of the magnetic induction $\beta(0)$ in the air gap and the current density $\alpha$ in the windings for the optimum variants was studied. This dependence forms the basis for the optimization of the MHD generator and the MHD power station. From the point of view of economy the results obtained are favorable. They show that ferromagnetic electromagnets certainly have their place in MHD generators. However, it must be remembered that these results are relative if it is considered that the MHD method of energy conversion, at the present stage of development, has accomplished only the first step towards industrial utilization. Author

N69-13319# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**STUDY OF ELECTRODES MADE REFRACTORY METALS FOR MHD GENERATORS UTILIZING NONEQUILIBRIUM CONDUCTIVITY [ISSLEDOVANIYE ELEKTRODOV IZ TUGOPLAVKIKH METALLOV DLYA MGD GENERATOROV S NERAVESNOY PROVODIMOST'YU]**
V. T. Karpukhin et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 60–68 refs (See N69-13314 03-03)
(SM-74/92) Avail: CFSTI

Results are described of experimental investigation of the emission characteristics of certain refractory metals and their alloys in a discharge, and of the investigation of the current distribution along the electrode suface and its dependence on the magnetic field. An estimate showed that for a current density of 1 to 5 amp/cm$^2$ in the channel of a Faraday type MHD generator with maximum segmentation of electrodes, the density of emission from separate electrode surfaces may increase to a few tenths amperes/cm$^2$. It is known that for generators utilizing nonequilibrium conductivity of the working substance, the requirement of uniformity of current in the generator volume is very important. All plasma inhomogeneities lower the output power of the generator. Therefore, uniform emission from the electrode surface is especially important. An analysis of the S-shaped emission curves of different refractory materials in the presence of cesium vapor, shows that at temperatures of the order of 1200 to 1500°K, thermionic current densities of a few tenths amperes/cm$^2$ are not possible. For this reason experiments were set up to determine the magnitude of the discharge current from the electrode surface as a function of the cathode material, its temperature, and the vapor pressure of cesium. The experiments were conducted on mercury-cesium and argon-cesium discharge. Author

N69-13325# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SOME RESULTS OF EXPERIMENTS WITH A 100-KW MH MHD GENERATOR MODEL [NEKOTORYYE REZUL'TATY EKSPERIMENTAL'NYKH ISSLEDOVANIY 100-KILOVATTNOY MODELI MGD GENERATORA]**
M. S. Berger et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 120–131 (See N69-13314 03-03)
(SM-74/212) Avail: CFSTI

Experiments were carried out with a model of a linear conduction MHD generator at fairly high levels of specific power, current density, and electric field strength. The MHD interaction was achieved in the fairly small model by raising the electrical conductivity of the working fluid by heating it to 3500 to 4500°K in an electric arc preheater. From the load characteristics the mean specific electrical conductivity of the gas under the experimental

conditions were estimated: at the generator inlet—180 mho/m; at the generator outlet—75 mho/m. These values coincided with those computed for equilibrium conditions. Losses at the electrodes were 30 to 40 V in the initial sections of the model and 110 to 120 V in the final sections. The experiments did not reveal any fundamental limitations in the operation of the MHD generator on passing to higher specific parameters. Experimental conditions were achieved under which the MHD interaction in the generator duct became the determining factor, while end effects and phenomena occurring at the walls and at the electrodes were less important.
Author

**N69-13329#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE EFFECT OF THE OUTPUT ON THE THERMAL EFFICIENCY IN ELECTRIC POWER STATIONS USING MHD GENERATORS [K VOPROSU O VLIYANII MOSHCHNOSTI ELEKTRICHESKIKH STANTSIY S MGD GENERATOROM NA IKH TEPLOVUYU EKONOMICHNOST]**
G. I. Rossiyevskiy et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 162–173 ref (See N69-13314 03-03)
(SM-74/204) Avail: CFSTI

The basic thermal scheme of an electric power station is examined in which the air is heated by gases coming out of the MHD generator and the residual heat of the combustion products (after heating the air) is utilized in the vapor turbine part of the power station. The overall efficiency of the power station with an MHD generator is determined by the efficiency of the MHD generator cycle and the vapor turbine part of the installation, which depends on the choice of the initial parameters of the vapor. At present this choice is almost unique because of the minimum unit power of turbines. Higher initial parameters for the vapor turbines can be chosen only if their unit power is sufficiently high. Equipment with supercritical initial parameters of the vapor should be examined as possible replacements for vapor turbine power stations.
Author

**N69-13331#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**EXPERIMENTAL INVESTIGATION OF THE MAGNETOHYDRODYNAMIC GENERATOR [EKSPERIMENTAL'NOYE ISSLEDOVAANIYE MAGNITOGIDRODINAMICHESKOGO GENERATORA]**
E. P. Strashnin et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 188–199 refs (See N69-13314 03-03)
(SM-74/206) Avail: CFSTI

Some results of investigations carried out in an experimental model of a linear MHD generator are discussed, on the combustion products of methane and oxygen seeded with an alkali metal salt. The MHD generator assembly consists of a combustion chamber, an operating channel, a magnetic system and associated equipment. The device is equipped with necessary measuring instruments. The combustion chamber is a cigar-shaped split structure with a detachable dispersal nozzle. The shape and dimensions of the nozzle vary, depending upon the particular problems to be investigated. A special feature of the combustion chamber is the jet ignition from a specially built-in diffusion burner, in which the gas and oxygen are tangentially fed from opposite directions. The ionizing impurity is introduced into the chamber by injecting an aqueous or alcoholic solution of an alkali metal salt. The combustion chamber is water-cooled and has an inner protective coating of fused magnesite. Liquid glass is used to provide the binding. The operating space of the combustion chamber is 8100 $cm^3$ and the maximum flow rate of the combustible mixture is 300 gm/sec.
Author

**N69-13332#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**EXPERIMENTAL INVESTIGATION OF VOLT-AMPERE CHARACTERISTICS OF A MAGNETOHYDRODYNAMIC CHANNEL WITH DIFFERENT ELECTRODES [EKSPERIMENTAL'NOYE ISSLEDOVANIYE VOLT-AMPERNYKH KHARAKTERISTIK MAGNITOGIDRODINAMICHESKOGO KANALA PRI RAZLICHNH ELEKTRODAKH]**
E. P. Strashnin et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 200–209 (See N69-13314 03-03)
(SM-74/208) Avail: CFSTI

The results are discussed of investigations of certain physical phenomena which occur in a channel operating on the combustion products of natural gas with oxygen at atmospheric pressure. The electrical conductivity of the plasma was sustained by ionizing additives which were introduced in the form of 20 to 40% solution of $K_2CO_3$ in water and KOH in alcohol. The experimental arrangement utilized a combustion chamber with flow rate of 200 gm/sec for the working mixture and with a matching nozzle which accelerated the plasma to a velocity of 500 to 600 m/sec. Different constructions of channels with ceramic lining were used. The voltage to the electrodes was supplied from a constant current generator.
Author

**N69-13333#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ELECTRICAL PARAMETERS OF A SYNCHRONOUS MAGNETOHYDRODYNAMIC GENERATOR WITH PULSATING ELECTRICAL CONDUCTIVITY OF MEDIUM [ELEKTRICHESKIYE PARAMETRY SINKHRONNOGO MGDG S PUL'SIRUYUSHEY ELEKTROPROVODNOST'YU SREDY]**
L. G. Bezusyy *In its* Intern. Symp. on Production of Elec. Power by means of MHD Generators 14 Nov. 1968 p 210–220 refs (See N69-13314 03-03)
(SM-74/210) Avail: CFSTI

The initial model of the generator used is constructed on the basis of a number of simplifying assumptions relative to the nature of the flow, geometry of the channel, and electromagnetic properties of the materials involved. Unidimensional stationary flow of a noncompressible working fluid with a velocity $v = |v|; 0; 0|$ is assumed, directed along the axis of a rectangular channel of constant cross section. The channel has two conducting and two nonconducting walls. The nonconducting walls contact the surface of the poles of a dc electromagnet, creating a homogeneous excitation field across the channel. The potential difference across the conducting walls, depending on the design of the generator, is assumed equal to zero or a certain constant value; at first only the case of equal potentials corresponding either to a rectangular channel with short electrodes or to a coaxial channel which can be approximately replaced by a rectangular channel is analyzed. It is assumed that the magnetic ciruit is made of a nonelectrical conducting material with infinite magnetic permeability, while the materials of the nonconducting wall and the working medium have magnetic permeability.
Author

**N69-13335#** Air Force Systems Command, Wright-Paterson AFB, Ohio. Foreign Technology Div.
**THERMODYNAMICS OF A TWO-COMPONENT LIQUID METAL MHD POWER PLANT WITH AN INJECTOR [TERMODINAMIKA DVUKHKOMPONENTNOY ZHIDKOMETALLICHESKOY ENERGETICHESKOY MGD-USTANOVKI S INZHEKTOROM]**
K. A. Yakimovich et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 233–243 refs (See N69-13314 03-03)
(SM-74/218) Avail: CFSTI

Among the schemes of MHD power equipment with liquid metal as the working substance, one in which a vapor-liquid injector is used for converting the thermal energy of the vapor into the kinetic energy of the liquid, has aroused considerable interest. This interest has resulted from the simplicity of construction of the converter and from the absence of moving parts in it; used in conjunction with the MHD generator (and if necessary with the electromagnetic pump), this converter can make the power equipment completely static. This last fact is very significant if the equipment is intended for a transport system. The problems related to the evaluation of the efficiency of the thermodynamic cycle with an injector and also of the efficiency of the vapor-liquid injector proper, were examined in a series of articles. Author

**N69-13336#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**CERTAIN PROBLEMS IN THE OPERATION OF A INSTALLATION WITH MHD GENERATOR [O NEKOTORYKH VOPROSAKH RABOTY USTANOVOKS MGD-GENERATOROM]**

V. A. Kirillin et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 244–257 refs (See N69-13314 03-03)
(SM-74/221) Avail: CFSTI

The most important problem of present day power engineering is that of increasing the economy of thermal and atomic power plants. This problem acquires special significance in the regions where the cost of fuel is high. One of the most obvious ways to obtain a steep increase in the initial temperature (which determines the economy of the installation) of the working substance in the thermal power plants, is the use of the magnetohydrodynamic method of coverting thermal energy into electrical energy. This method is highly promising in many other cases also, for example in installations with minimum overall characteristics, in equipment with large power transient operation, etc. Specific points related to the problem of building power plants using MHD generators with open as well as closed cycles are examined. Author

**N69-13340#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**REACTIONS OF REFRACTORY MATERIALS WITH THE GAS STREAM IN THE MHD GENERATOR DUCT [ISSLEDOVANIYE PROTSESOV VZAIMODEYSTVIYA ZHAROPROCHNYKH MATERIALOV S GAZOVYM POTOKOM V KANALE MGD-GENERATORA]**

A. I. Rekov *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 280–287 refs (See N69-13314 03-03)
(SM-74/228) Avail: CFSTI

The test materials for models of the combustion chamber and duct of an MHD ganerator ware chosen on the basis of the gas stream properties and preliminary studies which gave the qualitative requirements for the materials. The most important are creep resistance and the chemical resistance to the gas stream itself and its admixtures in the case of lining materials; in the case of electrodes and electrical insulation of the duct, electrical conductivity imposes an additional restriction. It should be noted that the structural properties of nonmetallic refractories cannot be calculated in advance to more than a limited extent. For example, a study of refractioness will permit only a comparative evaluation of the materials. The design of the individual elements and the allowable operating conditions for them can be finally determined only after model or full-scale tests. Author

**N69-13345#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**THERMODYNAMIC CHARACTERISTICS OF HIGH TEMPERATURE OPEN CYCLES [TERMODINAMICHESKIYE OSOBENNOSTI VYSOKOTEMPERATURNYKH OTKRYTYKH TSIKLOV]**

G. M. Schegolev *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 328–337 refs (See N69-13314 03-03)
(SM-74/235) Avail: CFSTI

The high temperature open cycle, like the ordinary gas turbine cycle, can be represented on an entropy diagram. However, the extension of this cycle into a region of temperatures exceeding 2500°K creates some significant features in its operation. The most important of these features are those related to the fact that the combustion products of the working substance undergo dissociation which can appear in the form of a significant increase in the specific heat. The specific heat of a dissociating gas can be considered as the sum of the ordinary specific heat and the specific heat induced by the effects of dissociative and recombination reactions. This specific heat is called the effective specific heat and like the degree of dissociation depends not only on the temperature, but also on the pressure. The examples presented show that purely thermodynamic analysis may prove to be a significant help in selecting the optimum cycle for a power plant using an MHD generator. Author

**N69-13348#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ON THE APPLICABILITY OF ELECTRODYNAMIC APPROXIMATION IN THE THEORY OF LIQUID METAL MHD ENERGY CONVERTERS [O PRIMENIMOSTI ELEKTRODINAMICHESKOGO PRIBLIZHENIYA V TEORII ZHIDKOMETALLICHESKIKH INDUKTSIONNYKH MGD-PREOBRAZOVATELEY ENERGII]**

Ya. Ya. Livelpeter *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 360–371 refs (See N69-13314 03-03)
(SM-74/240) Avail: CFSTI

In the theory of liquid metal MHD induction converters the process of energy conversion is described under the assumption of plane parallel flow of the liquid metal in the channel of the machine, i.e., the problem is treated in electrodynamic approximation. In this approximation the basic electromagnetic characteristics of the converter, the power transferred from the liquid metal to the stator or from the stator to the liquid metal, the power factor, the efficiency, and so on, can be obtained relatively simply. The results show that the main reason for the disagreement between the observed and computed values of the operating characteristics of MHD induction converters is the difference between the computed and actual values of the electromagnetic pressure and not the traveling field effect on the flow structure and the increase in the hydraulic loss. This conclusion is valid for converters with relatively long channels where reversible hydraulic processes along the channel length can be neglected. Author

**N69-13349#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**SOME RESULTS OBTAINED BY STUDY OF MAGNETOHYDRODYNAMIC ENERGY CONVERSION [NEKOTORYYE REZUL'TATY ISSLEDOVANIYA PROBLEMY MAGNITOGIDRODINAMICHESKOGO PREOBRAZOVANIYA ENERGII]**

K. Y. Donskoy et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 372–387 refs (See N69-13314 03-03)
(SM-74/241) Avail: CFSTI

The flow of low temperature plasma in ducts of MHD converters was studied. The electrical conductivity and the current density in a MHD duct can be increased by imposing a magnetic and electric field on the electron gas. This increase is particularly appreciable in the case of supersonic flows. In conjunction with

this it should be noted that the Mach number in papers devoted to determining the optimum Mach number at the inlet to a duct containing isothermal plasma should be increased. Author

**N69-13350#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE PROBLEM OF DETERMINING THE DIMENSIONS OF AN MHD CHANNEL [K VOPROSU O DIMENZIONIROVANII MGD-KANALA]**
I. D. Urusov *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 388–404 refs
(See N69-13314 03-03)
(SM-74/242) Avail: CFSTI

Usually the first step in designing rotary electric machines is to solve the problem of dimensions, i.e., to make a choice about the main dimensions (diameter of the hollow portion, length of the active part of the machine). The final choice, subject to certain optimum conditions, enables one to carry out the subsequent detailed computations by a more precise definition of specific parameters and characteristics, necessary for working out the technical plan of the electrical equipment and its technical-economical indices. An analogous problem of determining the dimensions arises also in sketching the design of a power plant containing MHD generators. It is necessary to have preliminary reference data for these generators at the initial stage in order to do the subsequent planning and to be able to make the technical-economical comparison of the variants of the entire power complex. A change in the electrical conductivity of the working gas significantly affects the length and the volume of the channel. By using the power law dependence for the electrical conductivity of the working gas, it is possible to take into account the effects of the pressure. Author

**N69-13352#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SPATIAL EFFECTS IN MHD CHANNELS WITH SEGMENTED ELECTRODES [PROSTRANSTVENNYYE EFFEKTY V MGD-KANALE S SEKTSIONIROVANNYMI ELEKTRODAMI]**
I. M. Tolmach *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 417–430 refs
(See N69-13314 03-03)
(SM-74/248) Avail: CFSTI

The distribution of the current density along the electrode in an MHD channel with two electrodes was studied. For this purpose one of the end electrodes was divided into a number of segments separated by insulators. All the segments had the same potential and it was possible to measure the current flowing into each segment, by a loop oscillograph. The cross section of the channel was 15.9 × 15.9 $mm^2$, the length of the electrode, 50.8 mm; the current flowing into the entire electrode was 0.8 amp. The Hall parameter was equal to unity in all the modes. The spacing between the segments was 1.06 mm. The ratios of the measured current flowing into segments 1, 2, and 3 to the total current (0.8 amp) are designated by points for different modes of operation of the channel. Since the current flows in all the segments, in all probability the process in the layer adjacent to the electrode did not involve arcing; this absence of arcing would bring the experimental condition close to the formulation of the theoretical problem. Author

**N69-13354#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**EXPERIMENTAL INVESTIGATION OF IONIZED GAS FLOW IN CHANNELS [EKSPERIMENTAL'NOYE ISSLEDOVANIYE TECHENIYA IONIZIROVANNOGO GAZA V KANALAKH]**
Ye. I. Yantovskiy *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 448–464 refs
(See N69-13314 03-03)
(SM-74/253) Avail: CFSTI

The object of the experiments was to accumulate data for channels with segmented electrodes, in nonstationary thermal regime on (1) the cooperative action of Faraday e.m.f., Hall e.m.f., and the e.m.f. due to the electron pressure gradient, and on (2) the effect of the resistance adjacent to the electrodes, the temperature of the electrodes and also the variation in gas conductivity inferred from the changes in the potential distribution. The influence of the load on the potential distribution is demonstrated along a frame type channel. In small experimental equipment the relative influence of Hall e.m.f., resistance adjacent to the electrodes, and electron pressure gradient, is significant. The observed potential distribution can be qualitatively explained by taking these factors into account. In the MHD generator, it is impossible to obtain a pure short circuit—inside the channel a considerable voltage is maintained. As a rule, in MHD generators utilizing Hall effect, it is impossible to obtain even a pure idle run, since inside the channel, currents continue to flow, affecting the potential distribution. Author

**N69-13357*#** Exotech, Inc., Rockville, Md.
**DESIGN, DEVELOPMENT AND FABRICATION OF A PRECISION AUTOCOLLIMATING SOLAR SENSOR (PASS)**
D. L. Fain, J. M. Hall, and D. F. Johnson Jun. 1968 112 p
(Contract NAS2-4050)
(NASA-CR-73260; TR-IC033) Avail: CFSTI CSCL 22B

This report summarizes the design, development, calibration, test and flight of the PASS (Precision Autocollimating Solar Sensor) for the SPARCS (Solar Pointing Aerobee Rocket Control System) program. The PASS concept was conceived and executed as a means of measuring the real time solar pointing error of the first two SPARCS flights in order to assess the performance of the attitude control system. In order to accomplish this to the required accuracy (better than 5 arc second), this unique sensor combined a high resolution solar sensor with an integral electronic readout autocollimator in a monolithic quartz structure permitting precise measurement of the angle between the solar vector and a reflective (reference) mounting surface independent of mounting errors and deflections induced by the launch and flight environment. The concept development, the design, testing and calibration program and flight history are discussed in detail, including the results of an additional flight experiment designed to evaluate the enhancement of matched solar cell pair performance through the use of properly selected bandpass filters. The solar experiment also yielded a standard block of cells/filters which have been calibrated against space sun data for use in the calibration and evaluation of future solar detectors. Author

**N69-13374#** Royal Aircraft Establishment, Farnborough (England).
**LARGE SOLAR CELL ARRAYS**
F. C. Treble Jan. 1968 39 p refs Presented at the ELDO Symp. on Propulsion, Paris, 10–12 Oct. 1967
(RAE-TR-68019) Avail: CFSTI

The state-of-the-art and development prospects of solar cells are reviewed. It is shown that thin single-crystal silicon cells offer the best hope of meeting requirements for the construction of large deployable arrays in the next few years. Possible methods of stowage, deployment and support are described and estimates of specific weight and area are presented for a typical case. Using 100 $\mu$ thick n-on-p silicon cells of current performance, arrays weighing less than 20 kg per kW and extending about 12 $m^2$ per kW appear to be attainable. The paper ends with a discussion of some of the problems to be overcome in the development, manufacture and testing of large arrays. Author (ESRO)

N69-13391*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**INVESTIGATION OF A LIQUID-METAL JET MHD GENERATOR**
K. I. Dmitriyev et al 1968 8 p refs Transl. into ENGLISH of a Russian paper presented at Symp. for the Generation of Elec. Power by Means of MHD Generators, Warsaw, 24–30 Jul. 1968
(Contract (NAS1-100)
(NASA-CR-97884; SM-107/134) Avail: CFSTI CSCL 10B

The use of a free liquid-metal jet emitted from an accelerating nozzle with a velocity of ≈ 100–150 m/s for converting kinetic energy into electrical energy makes it possible to reduce several times over the friction losses in the generator and to eliminate completely the losses in the conducting walls of the duct. However, the extraction of power from a free jet depends essentially on its stability in crossed magnetic and electric fields. The paper deals with an experimental study on the use of a free jet for MHD energy conversion. The results are given of experiments with a jet MHD generator employing a liquid-metal sodium circuit under different operating conditions (no-load, short-circuit, various loads).
Author

N69-13422*# Mechanical Technology, Inc., Latham, N. Y.
**COMPARISON OF CREEP AND ROTOR DYNAMICS IN THREE CESIUM AND THREE POTASSIUM VAPOR TURBOALTERNATORS**
D. W. Mc Laughlin and R. L. Thorkildsen 29 Dec. 1967 108 p refs Prepared for Oak Ridge National Lab.
(NASA Order W-12353; Contract W-7405-eng-26)
(NASA-CR-98514; MTI-67TR93) Avail: CFSTI CSCL 10B

A complete discussion of the detailed results of the creep and rotor dynamics analyses is presented. It was shown that the cesium turbines were acceptable in their present configurations. Creep growth in the first stage at the end of 40,000 hours of operation was expected to be less than 3 mils. The potassium turbines, on the other hand, were unacceptable at the design temperatures proposed for them. It was found that creep in the potassium turbines could be reduced to the level of the cesium turbines by lowering first stage turbine temperatures to about 1850 to 1900°F. It was concluded that the self-acting (hydrodynamic), four-pad, tilting pad journal bearing, with preload, was most suitable for these applications. The rotor dynamics studies showed that all of the rotors except that of Case 6 were acceptable designs with a substantial safety margin.
Author

N69-13423*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
**ESTIMATION OF MOISTURE FORMATION AND DEPOSITION AND OF THE THRESHOLD FOR TURBINE BUCKET EROSION IN POTASSIUM AND CESIUM VAPOR TURBINES Final Report**
T. C. Varljen and C. M. Glassmire Jan. 1968 45 p refs
(NASA Order W-12353)
(NASA-CR-98513; WANL-PR(CCC)-004) Avail: CFSTI CSCL 10B

The Oak Ridge National Laboratory is engaged in a comparative study of cesium and potassium vapor turbine-generator units for space power systems. The following summarizes the areas at work which are reported herein: (1) a condensation analysis of the four reference turbines was performed. Estimates were made of the moisture content of the working fluids in each stage and of the size and number distribution of condensate drops; (2) blade contours for each stator row of interest were generated; (3) moisture collection rates were estimated for each stator row; (4) the transport of atomized drops between stator and rotor sections was examined; (5) the geometrical aspects of drop impaction on the eight selected rotor blade rows was examined and parametric results obtained for the magnitude of normal impact velocities and the possible extent of eroded regions; and (6) the threshold velocities for mechanical erosion of the reference rotor blades was estimated.
Author

N69-13454# Battelle Memorial Inst., Columbus, Ohio.
**STUDY OF SPACE BATTERY ACCELERATED TESTING TECHNIQUES. PHASE 1 REPORT. SURVEY OF TESTING METHODS APPLICABLE TO SPACE BATTERY EVALUATION**
R. E. Thomas, E. W. Brooman, J. Waite, and J. McCallum Sep. 1968 65 p refs
(Contract NAS5-11594)
(NASA-CR-97935) Avail: CFSTI CSCL 22C

Testing procedures are to be developed to accelerate the aging of electrochemical cells so that years of data may be acquired in significantly less time to enable a valid prediction of cell life. The program is divided into three phases. The first phase is to conduct a literature survey. A literature survey of accelerated testing has been made with special reference to spacecraft batteries. Although increased sophistication is shown in measuring equipment and data processing, the survey shows that considerable differences exist among published investigations with respect to basic definitions, terms, and concepts. In particular, the terms "stress", "quality", and "failure" need to be defined in ways that are consistent with laboratory measurement techniques and possible physical mechanisms associated with degradations of quality over time. It is concluded that the greatest single difficulty in accelerated testing consists of obtaining quantitative evidence that the dominant failure mechanisms are not changed by increasing the stress level.
Author

N69-13470*# Electro-Optical Systems, Inc., Pasadena, Calif.
**ANALYSIS OF ELECTRIC PROPULSION ELECTRICAL POWER CONDITIONING COMPONENT TECHNOLOGY. VOLUME 1: DATA BANK Final Report**
L. Klynn, P. Jalichandra, and R. Shatuck 1 Apr. 1968 463 p
(Contract NAS8-11257)
(NASA-CR-97923; EOS-5400-Vol-1) Avail: CFSTI CSCL 10B

A compilation of data is presented pertaining to electric propulsion. The main topics delineated in the design data bank were: power source technology, electric thruster technology, and power conditioning. Trends leading to future performance improvements were identified where possible. A format was selected such that annual updating would make the most recent data always available to mission planners. Using the design data bank as a foundation, power conditioning was studied for: 40 to 50 kW, 1 to 5 MW, and 150 kW solar electric propulsion systems. A solar electric propulsion system was designed for an unmanned Mars spacecraft. Optimization procedures were demonstated on power conditioning for a 50 kW (1 AU) solar panel operating sixteen 2.5 kW cesium electron bombardment thrusters. Electric, magnetic, and thermodynamic interactions between various subsystems were investigated.
Author

N69-13662# Union Carbide Corp., Parma, Ohio.
**HYDRAZINE-AIR FUEL CELL SIMPLIFICATION Final Report, 15 Dec. 1967–15 Jun. 1968**
M. B. Clark and K. V. Kordesch Oct. 1968 52 p refs
(Contract DAAB07-68-C-0163)
(AD-676873; ECOM-0163-F; FR-2) Avail: CFSTI CSCL 10/2

The purpose of the contract was the evaluation of simple concepts for small hydrazine-air fuel cell systems in the power range of 10 to 60 watts. The main objectives of the contract were: (a) the elimination of complicated fuel-injection devices and their associated electronic circuitry; (b) the activation of units rapidly with electrolyte containing high concentrations of hydrazine; (c) the evaluation of cell components for maximum performance characteristics, including efficiency, life, and water balance, and (f) the adaptability of the fuel battery for use in a hybrid system.
Author (TAB)

**N69-13884*#** Electro-Optical Systems, Inc., Pasadena, Calif.
**STUDY OF A MULTIPLE RESERVE ELECTROCHEMICAL POWER SOURCE**
A. Thompkins and M. Klein 8 Nov. 1968 46 p refs
(Contract NAS7-672)
(NASA-CR-97859; EOS-4008-Final) Avail: CFSTI CSCL 10C

A study program was carried out which included limited experimental work to determine the feasibility of metal oxygen primary batteries for multiple reserve use. Cadmium, iron, and magnesium anodes were evaluated coupled with oxygen. The concept consists of a series connected monoblock that contains the anode, electrolyte, oxygen electrode, and a gas fed manifold. When power is required, oxygen from a lightweight high pressure storage vessel is fed through a pressure reduction regulator to the monoblock. In periods of nonuse, the oxygen source is closed and the battery remains in the ready condition. Author

**N69-13890#** Union Carbide Corp., Parma, Ohio.
**HYDRAZINE-AIR FUEL CELL SIMPLIFICATION STUDIES Quarterly Report, 15 Dec. 1967–15 Mar. 1968**
M. B. Clark and K. V. Kordesch Jul. 1968 28 p refs
(Contract DAAB07-68-C-0163)
(AD-676872; ECOM-0163-1; QR-1) Avail: CFSTI CSCL 10/2

The purpose of the contract is the evaluation of simple concepts for small hydrazine-air fuel cell systems in the power range of 10 to 60 watts. The main objectives of the first half of the contract were: (a) the elimination of complicated fuel-injection devices and the associated electronic circuitry; (b) the ability to activate units rapidly with electrolyte containing high concentrations of hydrazine, and (c) ready adaptability to many end uses in batteries with a variety of combinations of size, voltage, and power level. Author (TAB)

**N69-13818*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**STUDY OF AN INDUCTION-TYPE LIQUID-METAL MHD GENERATOR**
Yu. A. Bakanov et al 30 Jul. 1968 12 p refs Transl. into ENGLISH from Russian Conf. Paper Presented at Symp. on the Production of Elec. Energy by Means of MHD-Generators, Warsaw, 24–30 Jul. 1968
(Contract NAS7-100)
(NASA-CR-97876; SN-107/160) Avail: CFSTI CSCL 10B

Details are given on the construction and testing of a three-phase liquid potassium magnetohydrodynamic generator, which was developed to experimentally verify theoretical statements assumed in designing the generator. Using the optimized calculation, basic dimensions of the generator were selected, such as pole division, number of poles, active length, gap in the liquid metal, number of turns of the helical duct, and transverse internal cross section. The electrical circuit contained a three-phase battery of capacitors needed for self-excitation. The test circuit make it possible to investigate the generator in the parallel operating mode (connected parallel with the external mains), and in the autonomous self-oscillating mode. Equations are derived to determine the loses in the generator, and the results of measuring the separate components of these losses are examined. Also described are measurements of the magnetic field, and test data on self-excitation with power output which were obtained repeatedly for different values of capacitances, load, and temperature of the liquid potassium. M.G.J.

**N69-13827#** Electric Storage Battery Co., Yardley, Pa. Research Center.
**HIGH ENERGY SYSTEM (ORGANIC ELECTROLYTE) Final Report, 15 Jun. 1967–15 Jun. 1968**
D. P. Boden, H. R. Buhner, and V. J. Spera Oct. 1968 126 p refs
(Contract DAAB07-67-C-0385)
(AD-676887; ECOM-0385-F; FR-10) Avail: CFSTI CSCL 10/3

The objective of the research were as follows: (1) to determine the cause of self-discharge in activated Li/CuF2 cells, and to find a practical solution to the problem leading toward the realization of a non-reserve primary battery. (2) To establish conditions for dry storage of Li/CuF2 cells which would provide a basis for the development of a reserve type cell. (3) Build and evaluate performance of 37 A.H. Li/CuF2 cells. Author (TAB)

# 04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

**N69-12602** Stanford Univ., Calif.
**THE REORIENTATION OF A HUMAN BEING IN FREE FALL**
Preston Gibson Smith, Jr. (Ph.D. Thesis) 1967 108 p
Avail: Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-17507

The object of this work is to determine how a freely falling human being can change the orientation (attitude) of his body by moving parts of the body relative to each other. To this end, four models of the human body are studied in connection with the following two problems: (1) How does the orientation of each part of the body change when the relative motions of the parts proceed in certain specified ways? (2) How, if at all, can the parts be moved relative to each other so as to bring the model from a given initial state to a given final state? In both problems it is assumed that the system is initially at rest so far as rotational motion is concerned. In the case of the first problem, results are presented for each of the four models considered; in three instances these results are in the form of plots showing possible reorientations for a typical human being. A general method of solution is given for the second problem, and this method is applied to a model of the human body. Dissert. Abstr.

**N69-12609** Michigan Univ., Ann Arbor.
**CAPILLARY PENETRATION OF LIQUIDS BETWEEN DISSIMILAR SOLIDS**
William Joseph O'Brien (Ph.D. Thesis) 1967 97 p
Avail: Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-15668

The purpose of this study was to develop and evaluate a mathematical model for the capillary penetration of a liquid between two dissimilar plates. An attendant aim was to apply the proposed model to problems in restorative dentistry involving capillary penetration by mouth fluids. In view of the many systems found where a liquid penetrates between different solid materials, such a model should find wide application. Experimental values of capillary penetration between combinations of three liquids and several solids were obtained using the hyperbola method. Experiments on the penetration of liquid around wax fillings in prepared extracted teeth were carried out. A radioactive tracer solution was employed and the relative amounts of penetration were assessed with a liquid scintillation spectrometer. The results were interpreted in the light of the derived equation. Leakage around dental fillings and denture retention are discussed using thermodynamic concepts. Dissert. Abstr.

**N69-12662** Stanford Univ., Calif.
**THE CONTRACTION RATE OF RAT CARDIAC CELLS IN RESPONSE TO PERFUSION: AN EXPERIMENTAL STUDY OF CELLS CULTURED *IN VITRO* AND THE FORMULATION OF A MATHEMATICAL MODEL**
Michael Antonio Savageau (Ph.D. Thesis) 1967 172 p
Avail: Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 67-17495

This paper describes an experimental study of cardiac cells *in vitro* and a mathematical model, based on these observations as well as mechanisms hypothesized at the molecular level. Rat hearts were dissociated into isolated cells. The cells were seeded in microcapillary tubes, which were placed in petri dishes filled with culture medium. A mathematical model, based on molecular mechanisms found in microorganisms and believed to function in higher organisms, was formulated. The model was then used to predict the dynamic responses observed experimentally. The agreement between theoretical and experimental results is good.
Dissert. Abstr.

**N69-12717#** School of Aerospace Medicine, Brooks AFB, Tex.
**NITROGEN AND HELIUM AS FACTORS AFFECTING DECOMPRESSION STRESS SEVERITY**
Henry B. Hale and Edgar W. Williams Jun. 1968 13 p refs
(AD-676133; SAM-TR-68-64) Avail: CFSTI CSCL 6/19

Endocrine-metabolic appraisal was made by means of a battery of urinary determinations in three experiments in which human volunteers were exposed to sequential changes in pressure and composition of the gaseous environment. In each test, there was exposure to a two-gas environment, either 48% oxygen - 52% nitrogen or 48% oxygen - 52% helium, with ambient pressure at 7 p.s.i.a. The objective was to quantify stress effects of the diluent gases, helium and nitrogen. Nonspecific stress was detected in each experiment, the sum of the deviations from control levels for ten urinary variables (including norepinephrine, epinephrine, 17-hydroxycorticosteroids, various electrolytes, and certain nitrogenous metabolites) serving to differentiate the effects of the different diluent gases. When the duration of exposure to the different two-gas environments was only 4 hours and there was brief, subsequent exposure to 3.5 p.s.i.a. (breathing 100% oxygen), nitrogen appeared to be the stronger stressor; with duration increased to 12 hours, helium was judged to be the stronger stressor.
Author (TAB)

**N69-12720#** School of Aerospace Medicine, Brooks AFB, Tex.
**SIMULTANEOUS DETERMINATION OF $Fe^{59}$, $Cr^{51}$ AND $I^{125}$, USING A GAMMA SPECTROMETER**
John W. Harper, James F. Green, and Donald F. Logsdon, Jr. May 1968 11 p refs
(AD-676136; SAM-TR-68-40) Avail: CFSTI CSCL 6/1

In scintillation spectrometry, there are methods for separating 59Fe from 51Cr activity, and 51Cr from 125I activity, but no standard method has been presented for the simultaneous measurement of 59Fe, 51Cr, and 125I. In this study, a well-type scintillation spectrometer and discriminator were used to determine the activity of these three isotopes in one sample. The procedure is based on the use of contributory factors which remain constant and can be used in the calculation of various blood parameters. The mixed sample was counted at each of three previously determined settings and corrected for background. Then, the net 59Fe count equaled the total count at the 59Fe setting; the net 51Cr count equaled 10% of the count at the 59Fe setting subtracted from the count at the 51Cr setting; and the net 125I count equaled the sum of 7.5% of the net 59Fe count plus 7.0 % of the net 51Cr count subtracted from the count at the 125I setting. The method can be used to separate the activity of any group of three or more gamma-emitting isotopes if their energy peaks are well separated.
Author (TAB)

**N69-12797#** Union Carbide Nuclear Co., Oak Ridge, Tenn.
**BIO-PARTICLE CARBON ANALYZER OPERATION AND MAINTENANCE MANUAL**
R. H. Stevens, comp. and H. A. Kermicle, comp. 30 Aug. 1968 53 p refs
(Contract W-7405-ENG-26)
(K-L-6211) Avail: CFSTI

Operation and maintenance of an instrument for analyzing individual biological particulates such as cells, pollen, and spores for carbon by sampling them from a drop of liquid media onto a moving wire and analyzing each particle separately in a solid-sample type of hydrogen flame ionization detector are described. The smallest detectable carbon weight is approximately $10^{-12}$ gram.
NSA

**N69-12860** Brown Univ., Providence, R. I.
**LARGE SPHERICAL CAPS IN LOW REYNOLDS NUMBER TUBE FLOW: A MODEL OF BLOOD FLOW IN CAPILLARIES**
Robert Milo Hochmuth (Ph.D. Thesis) 1967 96 p
Avail: Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 68-1465

Blood flow in the capillaries of living systems is characterized by the motion of large, flexible, disc-like red cells suspended in a Newtonian liquid (plasma) which flows through the capillaries at low Reynolds numbers. In order to gain an understanding of capillary flow, the stability, velocity, and additional pressure drop (in excess of the Poiseuille drop) associated with the motion of large, rigid, neutrally buoyant spherical caps were studied for low Reynolds number flow through a 1 cm glass tube. It was found that spherical caps were stable in an orientation in which the base plane was perpendicular to the direction of flow. For spherical caps in this stable orientation, measurements of the velocity and the additional pressure drop revealed that both were relatively independent of cap thickness and cap spacing, but depended strongly on the cap diameter. The experimental results were used to calculate capillary pressure drops, and a possible mechanism for non-linear pressure-flow characteristics is suggested.
Dissert. Abstr.

**N69-12863** Stanford Univ., Calif.
**THE DISPERSION AND DISSIPATION OF WAVES IN BLOOD VESSELS**
James Arthur Maxwell (Ph.D. Thesis) 1967 113 p
Avail: Univ. Microfilms: HC $5.60/Microfilm $3.00 Order No. 67-17464

Dispersion and dissipation phenomena associated with waves propagating in blood vessels are potential measures of the distensibility of the vessels and other cardiovascular parameters. We assume the vessels to behave like thin-walled circular cylindrical shells filled with an inviscid compressible fluid. The vessel wall is assumed to have isotropic and homogeneous viscoelastic properties. The waves are described by small three-dimensional displacements of the middle surface of the shell from an equilibrium configuration defined by a mean transmural pressure and an initial axial strain. The fluid motion associated with the waves is considered as irrotational. The linearized differential equations of motion are based on the shell equations derived by Flügge.
Dissert. Abstr.

**N69-12865** Catholic Univ. of America, Washington, D. C.
**A PHASE CONTRAST CINEMICROGRAPHIC ANALYSIS OF THE EFFECTS OF ELEVATED OXYGEN TENSION ON CELL DYNAMICS IN STRAIN L CELLS**
Nicholas Ferencz, Jr. (Ph.D. Thesis) 1967 77 p
Avail: Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 67-17144

Phase contrast cinemicrographic methods and fixed preparations were used to ascertain the effects of prolonged exposure of Strain L cells to Eagle's Minimum Essential Medium which was gassed with a mixture of 95 percent oxygen and 5 percent carbon dioxide. Several techniques were developed, one of which allows a cell culture to be filmed and exposed to gassed medium simultaneously. This was accomplished by gassing medium in a specially constructed glass vessel and intermittently allowing the gassed medium to flow into a growth chamber. A basically similar system was developed whereby six sister cultures were perfused simultaneously with gassed medium from the same reservoir. A gravity recovery method for collecting synchronously dividing cells on glass coverslips was developed and is described. Dissert. Abstr.

**N69-12883#** Atomic Energy Commission, New York. Health and Safety Lab.

**THE RADIATION FIELD IN AIR DUE TO DISTRIBUTED GAMMA-RAY SOURCES IN THE GROUND**

H. Beck and G. de Planque May 1968 59 p refs

(HASL-195) Avail: CFSTI

A much more complete and detailed picture of the external environmental $\gamma$-ray radiation field has been obtained through $\gamma$-ray transport calculations of exposure rates, differential energy spectra, integral exposure rate spectra, and angular exposure rate distributions due to sources distributed on or in the soil half space. The radiation field is examined not only for the natural emitters $^{40}K$, $^{238}U$, and $^{232}Th$ but also for $\gamma$-rays whose energies are typical of weapons test fallout. The energy spectra and exposure rate angular distributions are shown to vary with detector height and source distribution with resulting important implications in regard to detector calibration and prediction of ground level exposure rates from aerial survey data. Exposure rate results as a function of detector height in air above the soil–air interface are tabulated for various source energies and source distributions. Although the calculated results are for specific soil and air densities, soil moisture and composition, the data can easily be adapted to other soil and air conditions. Author (NSA)

**N69-12886** Michigan Univ., Ann Arbor.

**THE DEVELOPMENT OF A PREDICTION MODEL FOR THE METABOLIC ENERGY EXPANDED DURING ARM ACTIVITIES**

Don Brian Chaffin (Ph.D. Thesis) 1967 294 p

Avail: Univ. Microfilms: HC $13.30/Microfilm $3.80 Order No. 67-17741

This study is an attempt to quantitatively combine the effects of the following factors to allow the prediction of a given person's metabolic energy expenditure: (1) the magnitude of external and inertial forces on the arm(s), (2) the position of the arm(s), and (3) the average speed at which a particular arm movement is performed. The empirical development is based on the concept that these factors can be characterized by a single dimension, which is the resultant torque(s) at the shoulder(s), elbow(s), or wrist(s). Measured metabolic energy expenditure rates of four subjects performing static arm tasks are reported. These disclose that the rate of metabolic energy expenditure by a person for a given level of torque at the shoulder, elbow, or wrist is also dependent on the following: (1) the torque direction (i.e., clockwise or counterclockwise rotation at the shoulder), (2) the angle at the elbow and shoulder, (3) the torque at adjacent articulations, and (4) whether one or both arms are active. The effects of each of these factors are combined into a whole arm metabolic prediction model for static activities. Dissert. Abstr.

**N69-12901#** Istituto Superiore di Sanita, Rome (Italy). Laboratorio di Fisica.

**ULTRASTRUCTURE OF THE TEGUMENT AND OF THE DIGESTIVE DUCT'S EPITHELIUM IN *DICROCOELIUM DENDRITICUM* (TREMATODA) [ULTRASTRUTTURA DEL TEGUMENTO E DELL'EPITELIO DEL CANALE DIGERENTE DEL TREMATODE DICROCOELIUM DENDRITICUM]**

S. Caiazza and G. Ferretti (Cagliari Univ., Italy) 12 Jun. 1968 20 p refs In ITALIAN; ENGLISH summary Supported by Consiglio Nazl. delle Ric.

(ISS-68/19) Avail: CFSTI

The tegument of the Trematode Dicrocoelium dendriticum is a syncytium formed by a superficial satratum connected by cytoplasmic tubules to the nucleated part of the cells which lies below the base membrane and the muscular layers. In the distal part of the caecum there is always a syncytial epithelium, but the nuclei are above the base membrane. The absorbing surface is greatly increased by the presence of microvilli and cytoplasmic ramifications. Author

**N69-12916#** Ballistic Research Labs., Aberdeen Proving Ground, Md.

**RADIOLOGICAL HAZARDS OF TRITIUM AND PROMETHIUM-147 ACTIVATED LUMINOUS DEVICES**

Richard H. Comer and John D. Knapton Sep. 1968 36 p refs

(AD-676112; BRL-MR-1934) Avail: CFSTI CSCL 6/18

The hazards associated with tritium and 147Pm activated luminous devices are considered. The primary hazard of tritium is due to the amount of tritium oxide which may be present. Eleven capsules were investigated for initial tritium purity and also for the amount of oxide that may be released in the event of an accidental breakage in room air. It was found that as much as 30% of the activity may be in the oxide form. The primary hazard of 147Pm is that of ingestion and the resulting dose to the LLI. An examination of a reasonable hypothetical radiological accident indicated that a dose exceeding 5 times the maximum permissible intake could be received from either a tritium or a 147 Pm luminous capsule. Author (TAB)

**N69-12919#** Army Natick Labs., Mass. Food Lab.

**NUTRIENT-DEFINED FORMULA DIETS FOR AEROSPACE METABOLIC EXPERIMENTATION Final Report, 31 Dec. 1964–30 Sep. 1967**

Henry A. Dymsza, Gilbert S. Stoewsand, and Herbert A. Hollender Brooks AFB, Tex. School of Aerospace Med. Apr. 1968 32 p refs

(AD-676138; SAM-TR-68-20) Avail: CFSTI CSCL 6/11

Nutrient-defined formula diets were developed for possible use in aerospace metabolic experiments or on experimental or operational missions. The diets include an aseptically canned liquid, a freeze-dehydrated diet, an instantized dry diet, compressed tablets and bite-size pieces, a chewable candy, and a baked cookie product. Whenever possible, only the most purified ingredients of known nutrient composition were used in the diet formulations. Taste-panel evaluations, chemical analyses, and human and animal feeding tests showed that many of the diet formulations were of acceptable organoleptic and nutritional quality. Further work is needed, however, on these and other forms of nutrient-defined formula foods which can meet the exacting nutritional and other specifications established by the Air Force and NASA for aerospace feeding systems. Author (TAB)

**N69-12945#** George Washington Univ., Alexandria, Va. Human Resources Research Office.

**EFFECTS OF CONTROLLED ISOLATION ON PERFORMANCE. PRESENTATIONS AND PAPERS, 1956–1961**

Mar. 1968 50 p refs

(Contract DA-44-188-ARO-2)

(AD-667630; HUMRRO-Paper-8-68) Avail: CFSTI CSCL 5/10

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6. EFFECTS OF SENSORY DEPRIVATION UPON RECEPTION OF COMPLEX INSTRUCTIONS: DEVELOPMENT OF A MEASURE R. D. McDonald p 31–32 (See N69-12951 03-04)

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**N69-12946#** George Washington Univ., Alexandria, Va. Human Resources Research Office.

**THE COUNTING OF AUDITORY STIMULI**

Richard A. Monty *In its* Effects of Controlled Isolation on Performance, Presentations and Papers, 1958–1961 Mar. 1968 p 1–6 refs Presented at Western Physiol. Assoc., Monterey, Calif., 1958 (See N69-12945 03-04)

Avail: CFSTI

An investigation is reported of a complex discrimination task in response to an auditory stimulus with many parameters (such as loudness, pitch, frequency, speed or repetition, and numerosity) appearing against certain background noise. All parameters except numerosity were held constant. It was found that error was directly related to numerosity and that a reduction in error was attributable to knowledge of results and was itself positively related to numerosity. Author

**N69-12947#** George Washington Univ., Alexandria, Va. Human Resources Research Office.

**INFLUENCE OF INSTRUCTIONS ON VERBAL REPORT OF VISUAL SENSATIONS UNDER CONDITIONS OF REDUCED SENSORY INPUT**

Donald B. Murphy, Edward J. Kandel, and Thomas I. Myers *In its* Effects of Controlled Isolation on Performance, Presentations and Papers, 1958–1961 Mar. 1968 p 7–11 refs Presented at Western Physio. Assoc., Monterey, Calif., 1958 (See N69-12945 03-04)

Avail: CFSTI

The subjects (42 basic trainees of superior intelligence) were taken into a semi-lightproofed office and given instructions of a positive-suggestive or negative-suggestive nature with respect to the possibilities of actual visual sensations in semi- or complete darkness. The positive instruction group reported a significantly greater number of visual sensations than did the negative instruction group and the sensations reported were significantly more complex. Author

**N69-12948#** George Washington Univ., Alexandria, Va. Human Resources Research Office.

**INFLUENCE OF PRIOR VERBALIZATION AND INSTRUCTIONS ON VISUAL SENSATIONS REPORTED UNDER CONDITIONS OF REDUCED SENSORY INPUT**

Edward J. Kandel, Thomas I. Myers, and Donald B. Murphy *In its* Effects of Controlled Isolation on Performance, Presentations and Papers, 1958–1961 Mar. 1968 p 12–18 refs Presented at the American Physiol. Assoc., Washington, 1958 (See N69-12945 03-04)

Avail: CFSTI

Thirty Army trainees received verbalization experience on selected Rorschach cards; another 30 had no Rorschach pre-test. Subsequently, half of the subjects in each group were instructed that it was normal to experience visual sensations in the absence of light; the other half were told that psychiatric patients experienced these visual sensations. Each subject then put on opaque goggles and lay on a bed in a darkened room. After 10 minutes the subject was asked to describe the visual sensations he was actually seeing. The positive instructions resulted in significantly more reports of visual sensations than the negative instructions; prior verbalization had no effect. Author

**N69-12949#** George Washington Univ., Alexandria, Va. Human Resources Research Office.

**STUDIES ON THE EFFECTS OF SENSORY DEPRIVATION UPON VIGILANCE. 1: PROGRESS IN THE DEVELOPMENT OF A VISUAL VIGILANCE TASK**

Richard A. Monty, Thomas I. Myers, and Donald B. Murphy *In its* Effects of Controlled Isolation on Performance, Presentations and Papers, 1958–1961 Mar. 1968 p 19–28 refs (See N69-12945 03-04)

Avail: CFSTI

The effects of sensory deprivation and social isolation on the individual were studied. A major research problem in this specific area is the development of measures that introduce minimum stimulation to the subject. This study is designed to develop a visual task that could be used to measure the effect of deprivation upon behavior. Author

**N69-12950#** George Washington Univ., Alexandria, Va. Human Resources Research Office.

**THE EFFECTS OF MISINFORMATION UPON THE COUNTING OF AUDITORY STIMULI**

Richard A. Monty, Thomas I. Myers, and Donald B. Murphy *In its* Effects of Controlled Isolation on Performance, Presentations and Papers, 1958–1961 Mar. 1968 p 29–30 Presented at the Western Physiol. Assoc., San Diego, Calif., 1959 (See N69-12945 03-04)

Avail: CFSTI

Subjects were given misinformation on blip items, interspersed with correct information in an experiment involving the ability to dount auditory stimuli. Author

**N69-12951#** George Washington Univ., Alexandria, Va. Human Resources Research Office.

**EFFECTS OF SENSORY DEPRIVATION UPON RECEPTION OF COMPLEX INSTRUCTIONS: DEVELOPMENT OF A MEASURE**

Robert D. McDonald *In its* Effects of Controlled Isolation on Performance, Presentations and Papers, 1958–1961 Mar. 1968 p 31–32 Presented at the Western Physiol. Assoc., San Diego, Calif., 1959 (See N69-12945 03-04)

Avail: CFSTI

Experiments were conducted to develop a simple motor task which would indicate the efficiency of reception of complex instructions in complete darkness after sensory or social deprivation. Army trainees were administered 10 tape-recorded problems. Analysis of variance indicated significant improvement in performance over trials; other experimental treatments had no effect. Author

N69-12952# George Washington Univ., Alexandria, Va. Human Resource Research Office.
**NOTES ON AN AUDITORY VIGILANCE TECHNIQUE**
Seward Smith and Paul M. Haas *In its* Effects of Controlled Isolation on Performance, Presentations and Papers, 1958–1961 Mar. 1968 p 33–36 Presented at the Western Physiol. Assoc., Seattle, Wash., 1961 (See N69-12945 03-04)
Avail: CFSTI

An auditory vigilance technique was developed for use in research involving sensory deprivation and social isolation. Subjects were placed separately in special rooms constructed to provide an average sound transmission loss of 40 decibels to sounds from the outside. They took the test while lying on a bed in a quiet lighted room. The subject's task was to operate a Lindsley manipulandum by releasing it as quickly as he could each time he heard a short tone. The technique produced a vigilance effect and a significant performance deterioration over time, and also minimized the adverse effects of such factors as sensory thresholds, motivation, signal rate expectancy, and drowsiness. Author

N69-12959*# Oak Ridge National Lab., Tenn. Biology Div.
**NEUROSPORA EXPERIMENT P-1037 Quarterly Progress Report, 16 Dec. 1966–15 Mar. 1967**
May 1968 43 p refs Supported jointly by NASA and AEC
(NASA Order R-104)
(NASA-CR-97867; ORNL-TM-2189) Avail: CFSTI CSCL 06S

Activities associated with the flight of Biosatellite A and the post-flight assays to determine the genetic effects of $^{90}Sr$ γ radiation in the ground control portion of the experiment are described. The flight material was not recovered; therefore only data on the ground control portion of the experiment is presented. Some of the data recording and electronic data processing techniques used for the Neurospora experiment are described and/or illustrated. NSA

N69-13049# Wisconsin Univ., Madison.
**THERMOLUMINESCENCE DOSIMETRY Annual Progress Report, 15 Jul. 1967–31 Aug. 1968**
John R. Cameron 31 Aug. 1968 98 p refs
(Contract AT(11-1)-1105)
(TID-24640) Avail: CFSTI

Thermoluminescent radiation dosimetry-related data is reported for properties of manganese-activated lithium tetraborate; ultraviolet repopulation of thermoluminescent traps in lithium fluoride; characteristics of dysprosium-activated calcium fluoride; use of natural calcium fluoride for ultraviolet dosimetry; color centers in strontium-activated monocrystals of potassium chlorides; color centers of magnesium-activated monocrystals of lithium fluorides; and FORTRAN 4 computer program for calculating thermoluminescent glow peaks and decay rates. NSA

N69-13167# Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics.
**MEASURING AVERAGE NEUTRON ENERGIES AND DOSE RATES AROUND A 20 MeV VAN DE GRAAFF ACCELERATOR WITH THE MULTI-SPHERE DETECTOR BY THE BLOCK-SHON TECHNIQUE**
B. R. Gifford, H. Mermagen, and H. D. Maillie 31 Jan. 1968 54 p refs Presented at the 13th Ann. Health Phys. Soc. Meeting, Denver, 16–20 Jun. 1968
(Contract W-7401-ENG-49)
(UR-49-894; CONF-680607-8) Avail: CFSTI

The neutron dosimetry system used at the Rochester 20-MeV tandem Van de Graaff accelerator is described. Various sized Bonner spheres, consisting of polyethylene-moderated europium-activated lithium iodide scintillation detectors, are used for neutron spectroscopy. The Block-Shon technique for measuring average neutron energies and dose-equivalent rates with the multisphere spectrometer system is discussed. Operating characteristics are listed in tabular form and graphically. NSA

N69-13194*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
**THE TRANSMISSION CHARACTERISTICS OF LARGE AND SMALL PRESSURE WAVES IN THE ABDOMINAL VENA CAVA**
Max Anliker, Michael K. Wells, and Eric Ogden (NASA, Ames Research Center) Nov. 1968 49 p refs
(Grant NGR 05-020-223)
(NASA-CR-98517; SUDAAR-382) Avail: CFSTI CSCL 06C

The mechanical behavior of the abdominal venae cavae of anesthetized dogs has been studied by measuring the speed, attenuation and changes in wave form of various kinds of artificially induced pressure signals. The propagation of large amplitude pressure waves is shown to be affected by reflection interference and pronounced nonlinear phenomena. For pressure signals exceeding a few mmHg the speed increases with amplitude and the wave front steepens during propagation as in the early phases of the formation of a shock wave. By inducing distension waves in the form of finite trains of sine waves with amplitudes less than 20 $mmH_2O$ the dispersion and attenuation were determined without requiring Fourier transform computations. The vena cava was found to be only mildly dispersive for frequencies between 20 and 100 Hz and the logarithmic decrement appears to be independent of frequency. Irrespective of the amplitude and shape of the pressure signals, their speeds varied along the vena cava and also with respiration. In addition the speeds generally increased under the influence of the chemical and electrical stimuli applied and with rising transmural pressure. Author

N69-13197 Purdue Univ., Lafayette, Ind.
**A QUANTITATIVE STATEMENT OF THE GENERATOR THEORY OF NERVE CELL FUNCTION**
Ronald John MacGregor (Ph.D. Thesis) 1967 109 p
Avail: Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-16675

The current work examines the behavior to be expected on the basis of a specific set of hypotheses concerning the mechanisms whereby incoming activity is integrated. It is assumed that potentials propagate on dendritic membrane according to the equation of electrotonus and that synaptic activation is effected by changes in membrane permeability. Conversion of the generator potential into output spike trains is handled by an empirical digital computer simulation of the physiological processes. Responses to synaptic activation are found to be inversely related to the size of the neural element. This provides a theoretical basis both for the observed higher excitability of smaller nerve cells and for the hypothesis that synaptic potentials in dendritic regions are considerably larger than those in somatic regions. Since the amplitude of a synaptic response depends upon the prior potential, this hypothesis provides the basis for a high degree of nonlinear interaction in dendritic regions. Dissert. Abstr.

N69-13211*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**IMPROVING BIOMEDICAL IMAGE QUALITY WITH COMPUTERS**
Robert H. Selzer 1 Oct. 1968 29 p refs
(Contract NAS7-100)
(NASA-CR-97899; JPL-TR-32-1336) Avail: CFSTI CSCL 06B

The analysis of pictorial data in the biomedical fields has increased sufficiently in the past few years to warrant the use of computers to process this data. A description of image processing

research, particularly in the area of image enhancement, is contained in this paper. Frequency response methods, which allow computer processing techniques to be directly related to the imaging system and to the image subject, are discussed. The most important enhancement technique, two-dimensional digital filtering, is described and illustrated with numerical examples. Examples of before-and-after computer-processed pictures are shown which illustrate low-pass, high-pass, high-frequency restoration, feature-selective and nonlinear filters. Subtraction techniques are also discussed and an example is given of a computerized film-measurement procedure that requires preprocessing of the image by filtering techniques. This application involves measurement of the width of trabecular bone shadows from X-ray film. Author

N69-13219# Royal Aircraft Establishment, Farnborough (England).
**A CONTRIBUTION TO THE PHYSIOLOGY OF ROTATIONAL NYSTAGMUS**
Taneji Masuda Jul. 1968 85 p refs Transl. into ENGLISH from Arch. Ges. Physiol. (Berlin, West Ger.), no. 197, 1922 p 1–65
(RAF-LIB-TRAN-1308) Avail: CFSTI

This paper describes an investigation into the physiology of the labyrinth in which the porpoise was used as an experimental animal. The animals were rotated at various speeds and observations were then made of the frequency and duration of the nystagmic eye movements thereby induced. Author

N69-13276*# Arkansas Univ., Fayetteville. Medical Center.
**[THE ROLE OF NUCLEOTIDE METABOLISM IN THE REPAIR OF RADIATION INJURY] Final Progress Report, Sep. 1966–Sep. 1968**
Glenn V. Dalrymple Sep. 1968 9 p refs
(Grant NGR-04-001-014)
(NASA-CR-97930) Avail: CFSTI CSCL 06R

The radiation effects on DNA, polymerase, nucleases, and the survival properties of cells were investigated under conditions of normal growth, DNP-treatment, and starvation. To study DNA synthesis, pulse and continuous labeling with P-32 was used in irradiated cells. Cells in growth medium showed no difference in P-32 labeling from non-irradiated control cells. Starved and DNP-treated cells showed discrete periods of accelerated labeling of DNA and RNA. No evidence of DNA degradation was found eight hours postirradiation in cells prelabeled with tritiated thymidine. It was found that radiation doses of 100 rads to 1000 rads did not alter polymerase or nuclease activities. Survival studies showed that DNP-treated cells had a significantly higher survival than cells in growth medium, and starved cells may have had a slightly higher survival than those in growth medium. A model is suggested which explains the repair process in terms of an enzyme that rejoins single-strand breaks in the DNA molecules. N.E.N.

N69-13436*# Public Health Service, Cincinnati, Ohio. Food Protection Research.
**ECOLOGY AND THERMAL INACTIVATION OF MICROBES IN AND ON INTERPLANETARY SPACE VEHICLE COMPONENTS Quarterly Progress Report, Jul. 1–Sep. 30, 1968**
Robert Angelotti and J. E. Campbell Oct. 1968 21 p ref
(NASA Order R-36-015-001)
(NASA-CR-98510; QPR-14) Avail: CFSTI CSCL 06M

Results of continuing research on dry heat inactivation of bacterial spores and the influence of spore moisture content on z values are reported. Lyophilization techniques for drying spores in thermal inactivation studies were discounted due to leakage around the vial stopper. Test use of 8 by 50 mm borosilicate glass tubes sealed in commercial tin cans was evaluated and found to be worthy of further study. Three spore crops of *B. subtilis* var. *niger* were produced and compared to the 1965 spore suspension which used stainless steel strips as a vehicle. All three had a heat resistance either equal to or greater than the original crop. Insonation methods for eluting dry spores from the glass tubes were found to be the most efficient. Z values were obtained for spores equilibrated at relative humidities of less than 10%, spores embedded in epoxy containing added water, and spores suspended in water. With the exception of a sharp drop for spores suspended in water, little difference in the values was noted regardless of the initial moisture. A.C.R.

N69-13458# Milan Univ. (Italy).
**SYNTHESIS OF 3– AND 4–14 C FRUCTOSE AND GLUCOSE WITH HIGH SPECIFIC ACTIVITY AND ULTRA-HIGH RADIOCHEMICAL PURITY [SINTESI DI GLUCOSIO E FRUTTOSIO 3– E 4–14 C AD ALTA ATTIVITA SPECIFICA ED ALTISSIMA PUREZZA RADIOCHIMICA]**
E. Sturani Brussels EURATOM Sep. 1968 31 p refs In ITALIAN; ENGLISH summary
(Contract EURATOM-083-64-11 RISI)
(EUR-4061.i) Avail: CFSTI

The object of this research was to synthesize glucose-3-$^{14}C$, fructose-3-$^{14}C$, glucose-4-$^{14}C$ and fructose-4-$^{14}C$. The 3PGA-1-$^{14}C$ was synthesized from ribulose 1–5 diphosphate and $NaH^{14}CO_3$ by means of ribulose diphosphate carboxylase refined from spinach leaves. Glucose and fructose were then obtained by way of purified enzymes. Author

N69-13465# Army Medical Research Lab., Fort Knox, Ky.
**CORRELATION BETWEEN THE GROSS AND MICROSCOPIC APPEARANCE OF CARBON DIOXIDE LASER INDUCED PORCINE SKIN BURNS Interim Report**
David K. Hysell and Arnold S. Brownell 17 Jun. 1968 24 p refs
(AD-676578; AMRL-778) Avail: CFSTI CSCL 6/18

The skin of white pigs exposed to CO2 laser radiation was biopsied and examined for histologic evidence of damage. As the burns increased in severity macroscopically, there was a commensurate increase in microscopic evidence of tissue damage. Limited data suggests that even though burns present similar surface appearances, those produced by high intensity CO2 laser power densities might have more actual tissue damage than those produced by a lower power density. Insufficient data was available to determine if the differences were significant. Author (TAB)

N69-13517# California Univ., Los Angeles. Dept. of Psychology.
**MECHANISMS OF ATTITUDE CHANGE PRODUCED BY FORCED COMPLIANCE Final Report**
Barry E. Collins Aug. 1968 5 p
(Grant AF-AFOSR-1200-67; ARPA Order 897)
(AD-676288; AFOSR-68-1916) Avail: CFSTI CSCL 5/10

When an individual is induced to play a role inconsistent with his private opinion, he often modifies that private opinion to make it consistent with his public role. This suggests that educators or propagandists with control over overt behavior can also gain control over thoughts or private opinions. In an earlier experiment, the principal investigator demonstrated that financial inducements to undertake the role could either facilitate or inhibit the attitude change. A series of experiments have investigated the conditions under which these financial inducements facilitate or inhibit attitude. Five of the seven experiments have been written up for publication; the entire series has been described in a paper presented at the American Association for the Advancement of Science. The experiments indicate that a fear of social retaliation from the audience is not an important factor and that public commitment to the overt behavior is an important factor in producing attitude change. Author (TAB)

N69-13518# Institute for Research, State College, Pa. Div. of Psychobiology.
**THE EFFECTS OF D-AMPHETAMINE UPON ACQUISITION, PERSISTENCE, AND RECALL**
Paul M. Hurst, Robert Radlow, and Sallyann K. Bagley 9 Sep. 1968 23 p refs
(Contract Nonr-4423(00))
(AD-676548; ONR-H-68-1) Avail: CFSTI CSCL 5/10

The experiment was designed to measure four component effects of d-amphetamine in a paired-associate learning task. The drug was compared with placebo to reveal (1) effects upon acquisition of new material, (2) persistence of material so learned, (3) effects of drug present during test of delayed recall, and (4) interactions between drug present during learning and drug present during test of delayed recall. Paired associates of varying degrees of usage frequency, association value, and intra-list competition were employed. Sixty-nine college males were tested in two sessions, for learning and delayed recall respectively. Presence of the drug during learning resulted in significantly greater delayed recall of the low-competition lists, and non-significantly greater delayed recall of high competition lists. The same dosage given for the recall session had no significant effect upon delayed recall or relearning.
Author (TAB)

N69-13638# Bhabha Atomic Research Center, Bombay (India).
**INVESTIGATIONS ON BASIC MECHANISMS OF RADIOSENSITISATION BY CHEMICALS**
B. B. Singh, V. T. Srinivasan, B. Y. Bhatt, and M. A. Shenoy 1968 25 p refs
(BARC-352) Avail: CFSTI

In order to enable the use of radiosensitizers in the preservation of food materials and sterilization of medical products by ionizing radiations, a detailed investigation was carried out on the basic mechanisms involved in the radiosensitisation phenomena. Although *Staphylococcus aureus* was selected as the main test organism in view of its role in food-poisoning and food-spoilage, *E. coli*. B/r was also used in certain experiments. The sensitising effect of iodoacetic acid was found to be due to the reaction of radiation-induced iodine atoms with the bacterial membrane proteins which might constitute the repair system. Vitamin $K_3$, which occurs in normal human metabolism and is well known for its anti-microbial and radiosensitising properties, was, therefore, selected for further investigations. The results obtained so far have demonstrated that it has high reactivity towards hydroxyl radicals and the transients thus formed cause the sensitisation.
Author

N69-13643*# Emory Univ., Atlanta, Ga. Dept. of Radiology.
**ENERGY DEPOSITION IN MICROSCOPIC VOLUMES BY HIGH-ENERGY PROTONS**
Jerald W. Hilbert and Norman A. Baily [1968] 24 p refs
(Grant NGR-11-001-026)
(NASA-CR-97911) Avail: CFSTI CSCL 06R

Measurements of the frequency distributions of the energy deposited as the result of the passage of high-energy protons through microscopic volumes of biological interest present some unique problems. A method is described which permits the determination of such distributions in arbitrarily shaped volumes having dimensions equivalent to fractions of a micron of unit-density tissue. The method is illustrated for a 1.77 micron diameter tissue sphere, irradiated with 40 MeV protons, and implications to other energies and geometries are made in terms of the generalizations possible from these results. Distributions for various depths in a tissue-like phantom are also presented.
Author

N69-13671*# IIT Research Inst., Chicago, Ill.
**LIFE IN EXTRATERRESTRIAL ENVIRONMENTS Quarterly Status Report, Aug. 15–Nov. 15, 1968**
[1968] 13 p
(Contract NASr-22)
(NASA-CR-97908; IITRI-L6023-15) Avail: CFSTI CSCL 06M

Experiments on the survival of microorganisms airborne in dust clouds showed that the viable cell count of *Bacillus cereus* and *B. subtilis* decreased 99% and *Staphylococcus aureus* decreased 99.9% while suspended in simulated Martian dust clouds for 28 days. The humidity and temperature of the test environment ranged from 40% to 60% RH and from 20° to 25°C, respectively. *Serratia marcescens* did not survive one day in the test environment. It is pointed out that the time factor and initial cell populations must be considered with decreasing viability determinations. In these studies the decreased viability took place within 14 days without any further significant change. If bacterial populations of $10^4$ to $10^6$ cells are considered, then the numbers of survivors are important to the contamination of Mars since populations between 10 and 100 cells of some organisms can survive and grow in a simulated Martian environment.
Author

N69-13679# Navy Medical Neuropsychiatric Research Unit, San Diego, Calif.
**A SET OF PROGRAMS FOR COMPUTING MULTIPLE CORRELATIONS AND RELATED STATISTICS. TWO ANALYSIS-OF-VARIANCE PROGRAMS FOR DISPROPORTIONATE CELL FREQUENCIES**
Cyril H. Nute, Ardie Lubin, and Donald D. Beck 1968 47 p refs
(AD-670592; REPT-67-9; REPT-67-11) Avail: CFSTI CSCL 5/10

A stepwise linear regression and multiple correlation program, with distinct accretion and deletion phases, has been developed for use with either complete or incomplete data. A companion cross-validation program makes it possible to test the derived regression coefficients by applying them to a different sample obtained from the same parent population. The difference between the multiple correlation and the cross-validity indicates the stability of the regression coefficients. The set of programs offers great versatility and high capacity. In theory it has been known for many years that by using the general linear model, multiple regression can give results that are identical to those of analysis-of-variance (ANOVA). In particular, multiple regression can give an ANOVA for disproportionate cell frequencies. Program GENIV does this for one-way, two-way, or three-way ANOVA. Program deviance performs two-way ANOVAS, automatically selecting every possible pair from a given set of predictors. Both programs generate all possible interaction variables. They binarize, (dichotomize), graded or ungraded raw predictor scores, assigning each subject to the specified levels of each factor.
Author (TAB)

N69-13682# Naval Radiological Defense Lab., San Francisco, Calif.
**TURBULENCE IN AN UNBOUNDED, UNIFORM-SHEAR FLOW: A COMPUTER ANALYSIS**
T. H. Gawain and John W. Pritchett 7 May 1968 171 p refs
(ARPA Order-96)
(AD-676883; NRDL-TR-68-86) Avail: CFSTI CSCL 19/4

Fluid turbulence is of crucial significance in many problems of scientific and technical importance. Current developments in computer technology offer the possibilities of solving the fundamental equations of turbulent flow in a way never before possible. In order to accomplish this aim, however, it is first necessary to formulate the essential theoretical concepts in a suitable manner. The report summarizes the progress achieved to date in this connection. Various essential basic equations are derived, but the emphasis is as much on fundamental concepts as on mathematical details. More specifically, a method is established for the computer simulation of the detailed stationary turbulence in a uniform shear flow. The results obtainable in this way are far more comprehensive than any which could reasonably be obtained by physical experiment. The

data generated represent fundamental information which may be subsequently analyzed to establish overall phenomenological characteristics of the turbulence. The concepts in the report should provide a sound basis for a systematic, sustained and productive research plan. They have already been successfully applied to a computer program which is now going into operation. Results of a typical computer run are included and illustrate qualitative agreement with theoretical predictions. Author (TAB)

**N69-13709#** Southwest Center for Advanced Studies, Dallas, Tex.
**THE DOSIMETRY AND RADIOBIOLOGY OF NEGATIVE PIONS. 4. WORK ACCOMPLISHED**
Chaim Richman, M. R. Raju, J. Feola, and G. W. Barendsen 25 Jun. 1968 25 p
(Contract AT(40-1)-3343)
(ORO-3343-2) Avail: CFSTI

Meson ($\pi^-$) dose distribution in water at 65 and 91 MeV, dose distribution in silicon detectors at 65 MeV, and the differential range in Lucite at 67 and 91 MeV are presented graphically. Also, integral dose distribution curves are given for 65-MeV meson ($\pi^+$) beams in a silicon detector. NSA

**N69-13843#** Yonsei Univ., Seoul (South Korea). Dept. of Physiology.
**METABOLIC ADAPTATION TO COLD Final Report, Sep. 1967–Sep. 1968**
Suk Ki Hong Oct. 1968 39 p refs
(Contract DA-CRD-AFE-S92-544-67-G76)
(AD-676850; J-292-2; AR-2) Avail: CFSTI CSCL 6/16

The results of a two-phase study on cold acclimatization in human subjects are reported. In the first phase, an investigation was undertaken to study the effects of norepinephrine infusion on the resting oxygen consumption, the skin heat flux and the blood pressure. In addition, the quantity of daily catecholamines excretion was also determined. In the second phase, an attempt was made to determine the maximal aerobic power of ama for a comparison with non-divers and established Korean athletes. In addition, their maximal aerobic power was also compared between the summer and the winter, since the duration of daily diving work considerably differs between the two seasons. TAB

**N69-13847#** Joint Publications Research Service, Washington, D. C.
**BIBLIOGRAPHY ON AEROSPACE MEDICINE AND BIOASTRONAUTICS FOR 1967**
L. I. Boreva 26 Nov. 1968 60 p refs Transl. into ENGLISH from the Russian
(JPRS-46947) Avail: CFSTI

Bibliographies on the following subjects are presented: general problems in space biology and medicine; biology; general physiology; neurophysiology and physiology of sense organs; psychology and psychiatry; biological, physiological, and psychological effects of environment and stresses; personnel (selection, training, professional activity, and questions of expertise); medical problems and pharmacology; toxicology; man–machine system; life support systems; and methods of investigation for biotelemetry, and data processing. A list of authors, and a system for classification of literature on aerospace medicine and bioastronautics is included. F.O.S.

**N69-13898#** Massachusetts Inst. of Tech., Cambridge. Dept. of Psychology.
**THE INFLUENCE OF OCULOMOTOR SYSTEMS ON VISUAL PERCEPTION Final Scientific Report**
Whitman Richards Jul. 1968 18 p refs
(Contract F44620-67-C-0085)
(AD-676703; AFOSR-68-2098) Avail: CFSTI CSCL 6/16

This report describes ongoing work on the influence of the oculomotor systems upon visual perception. Three different problems are being considered: (1) Saccadic suppression, (2) Size-scaling, and (3) The corridor illusion. Of particular interest is whether or not efferent or outflow mechanisms play a significant role in these perceptual phenomena. A perspective illusion of depth has been examined in order to show that planar illusions involve mechanisms different from those underlying size/depth invariances. Author (TAB)

# 05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and pi'oting. For related information see also: 04 Biosciences.

**N69-12721#** Life Sciences, Inc., Fort Worth, Tex.
**THE EFFECTIVE TIME CONSTANT IN TRACKING BEHAVIOR Technical Report, Oct. 1966–Oct. 1967**
W. G. Matheny and D. A. Norman Orlando, Fla. Naval Training Device Center Aug. 1968 65 p refs
(Contract N61339-67-C-0034)
(AD-675806; NAVTRADEVCEN-67-C-0034-3) Avail: CFSTI CSCL 5/8

The purpose of this study was to derive a construct based upon properties of man and machine which could be postulated to be related to level of precision of control in closed loop tracking by the human operator. A construct, termed the Effective Time Constant (te), was developed. For second order systems te is derived from the gain (K), frequency (omega) and damping (zeta) of the machine and the threshold (T) of the human operator. For first order systems the machine properties are gain (K) and machine time constant (taw). Two experiments designed to test the postulate that te is related to level of control were conducted. The Effective Time Constant was found to be related to rate of improvement in performance and to overall level of control. However, the results indicate that absolute level of control may be more precisely predicted from the product (Kte) of the Effective Time Constant and gain. This interactive effect has its greatest effect in early training trials and diminishes with practice. The implications of the results for fidelity of simulation, adaptive training and the study of basic psychomotor skills are discussed. Author (TAB)

**N69-12726#** Life Sciences, Inc., Fort Worth, Tex.
**PILOT PERFORMANCE. TRANSFER OF TRAINING AND DEGREE OF SIMULATION. 3: PERFORMANCE OF NON-JET EXPERIENCED PILOTS VERSUS SIMULATION FIDELITY Technical Report, Nov. 1966–Nov. 1967**
N. C. Ellis, A. L. Lowes, W. G. Matheny, and D. A. Norman Orlando, Fla. Naval Training Device Center Aug. 1968 76 p refs
(Contract N61339-67-C-0034)
(AD-675825; NAVTRADEVCEN-67-C-0034-1) Avail: CFSTI CSCL 1/2

This is the fourth report in a study program dealing with pilot performance, transfer of training and degree of simulation. The purpose of this study was to repeat a previously conducted transfer of training study using non-jet experienced pilots as subjects. Its primary objective was to determine the training feasibility of using degraded levels of simulation fidelity in an Operational Flight Trainer

(OFT). Simulation fidelity was varied by incorporating coefficient changes into the aerodynamic equations of flight such that rigid coefficients and least squares approximations to flexible coefficients served as the experimental conditions and flexible coefficients served as the control condition. Author (TAB)

**N69-12859** University of Southern Calif., Los Angeles.
**SYNTHESIS AND IDENTIFICATION OF MATHEMATICAL MODELS FOR THE DISCRETE CONTROL BEHAVIOR OF HUMAN OPERATORS**
Michael James Merritt (Ph.D. Thesis) 1967 199 p
Avail: Univ. Microfilms: HC $9.00/Microfilm $3.00 Order No. 67-17689

This dissertation describes the synthesis and identification of mathematical models which characterize the discrete control behavior of human operators. This type of behavior occurs in control situations where the human operator must decide between a small number of alternatives, while generating continuous control actions at the same time. A systematic treatment of discrete control actions is made possible by the introduction of two new elements which can be used to configure complete human operator models. Two types of hybrid elements are presented. One accepts continuous inputs and produces binary outputs, while the other has continuous inputs and produces continuous outputs under the control of binary signals. Dissert. Abstr.

**N69-12973#** Mount Auburn Research Associates, Inc., Cambridge, Mass.
**SYSTEM STUDY, DESIGN, TEST AND EVALUATION OF CONCEPTS FOR MARKING OF LOW VISIBILITY AVIATION OBSTRUCTIONS Final Report**
James C. Woo Jun. 1968 80 p refs
(Contract FA67W-1718)
(SRDS-RD-68-58) Avail: CFSTI

A system study was carried out to determine the requirements for effective marking of overhead obstructions of low visibility that are potential aviation hazards. The design of effective markers is based on a knowledge of vision through the atmosphere. A simple theory on the subject is presented. Design concepts based on the theory to meet the requirements determined from the system study are proposed. The concepts are evaluated and tested with models in laboratory and in actual field conditions. Engineering designs of these concepts are also furnished. Author

**N69-13072** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**COGNITIVE INFORMATION PROCESSING**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 153-167 refs (See N69-13060 03-34)
(Contract DA-28-043-AMC-02536(E) Grants NIH 1-P01-GM-14940-01; NIH 1-P01-GM-15006-01)
Avail: CFSTI

Reviews of research in cognitive information processing are presented. A character recognition reading machine was developed and provision was made for the effective control of its operation by a blind person. Experiments were conducted to compare different modes of specifying the reading speed and the location on the page of the text to be read. A computer simulation was made of a character recognition type of reading machine with a spelled speech output. Blind subjects were allowed two means of controlling the reading process. A graphical interpretation of calculating the output signal of a linear time variant filter with a digital computer is presented. Surfaces are reconstructed for contour samples of constant elevation; the contours were treated as boundary conditions on which the value of the surface is known and the surface reconstructed by solving Laplace's equation. A display system is described which was designed as a research tool for tactile experiments to determine the feasibility of word-at-a-time presentation of Braille to the blind. B.P.

**N69-13073#** Massachusetts Inst. of Tech., Cambridge. Research Lab of Electonics.
**COMMUNICATIONS BIOPHYSICS**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 169-189 refs (See N69-13060 03-34)
(Contract DA-28-043-AMC-02536(E); Grant NIH 1-P01-GM-14940-01)
Avail: CFSTI CSCL 06B

A preliminary model of binaural hearing is presented in which the firing patterns on the auditory nerve are regarded as inputs to a central processor and behave randomly. The representation of the firing patterns is based on data taken from the cat's auditory nerve. An experiment was performed on time and amplitude interaural just-noticeable differences (JND) both on and off the midline (position of signal image in perceptual space) with a common experimental configuration and set of subjects. Another experiment was performed to determine the JND in frequency as a function of duration for a stimulus in which the frequency discrimination was based purely on time information. The stimulus was chopped, white, Gaussian noise, and the aspect of the stimulus to be discriminated was the chopping rate. The effect of the just-previous trial on a subject's response was studied in the context of a monaural, two-alternative-forced-choice, intensity-discrimination task. The extent to which confidence ratings or second choice paradigms might be used in the task of absolute identification was explored. B.P.

**N69-13074#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**NEUROPHYSIOLOGY**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 191-229 refs (See N69-13060 03-34)
(Contracts NSR-22-009-138; AF 33(615)-3885; Grant NIH 5-RO1-NB-04985-04)
Avail: CFSTI CSCL 06H

Progress in neurophysiological research is reported. The state transition matrix was applied to investigate shift register networks. An extensive inductive argument is presented on judging color (including brightness) of colored things. The elements of the sensory space of color are reviewed and applied to evaluate Dr. Land's experiments with color. B.P.

**N69-13132#** George Washington Univ., Alexandria, Va. Human Resources Research Office.
**TRAINING OF RADAR OPERATORS AND MAINTENANCE PERSONNEL**
Jun. 1968 45 p refs
(Contract DA-44-188-ARO-2)
(AD-674165; HUMRRO-Papers-20-68) Avail: CFSTI CSCL 5/9

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N69-13133# George Washington Univ., Alexandria, Va. Human Resources Research Office.
**A PERFORMANCE TEST FOR THE IAAFCS M33 RADAR MECHANIC AND OBSERVATIONS ON TROUBLESHOOTING BEHAVIOR**
Robert Vineberg *In its* Training of Radar Operators and Maintenance Personnel Jun. 1968 p 1–10 refs Presented at the Symp. on Electron. Maintenance, Aug. 1955 (See N69-13132 03-05)
Avail: CFSTI

The development of a performance test designed to measure ability of radar mechanics in the energizing and operation of equipment, in field adjustments and preventive maintenance, and in troubleshooting, is described. Data from the administration of the test to experienced and inexperienced antiaircraft mechanics are furnished. Author

N69-13134# George Washington Univ., Alexandria, Va. Human Resources Research Office.
**STUDIES OF FIELD ACTIVITIES OF ARMY ELECTRONICS MAINTENANCE PERSONNEL**
George J. Wischner, Abram M. Barch, and Joseph C. Hammock *In its* Training of Radar Operators and Maintenance Personnel Jun. 1968 p 11–20 refs Presented at the Symp. on Electron. Maintenance, Aug. 1955 (See N69-13132 03-05)
Avail: CFSTI

In this paper a description of three studies of field activities, problems, and difficulties of Army electronics maintenance personnel offers information bearing on the methodology employed, the kind of data gathered and their utility and implications for training. The objective of the research was to work toward job-oriented training geared more directly to field use. Author

N69-13135# George Washington Univ., Alexandria, Va. Human Resources Research Office.
**AN ANALYSIS OF PROBLEM SOLVING FOR USE IN TROUBLESHOOTING RESEARCH**
Robert Vineberg *In its* Training of Radar Operators and Maintenance Personnel Jun. 1968 p 21–28 refs Presented at the Symp. for American Physiol. Assoc., San Francisco, Calif., Sep. 1955 (See N69-13132 03-05)
Avail: CFSTI

This paper presents an analysis of the approach trouble-shooting mechanics take—ranging from symbolic processes to physical manipulations—in maintaining electronic equipment. The symptom-formulation-performance sequence is described. Research into the role of different variables affecting troubleshooting responses is suggested. Author

N69-13136# George Washington Univ., Alexandria, Va. Human Resources Research Office.
**DIAGNOSIS AND TREATMENT OF AN ARMY ELECTRONICS TRAINING COURSE**
James E. Whipple, Robert F. Mager, and Lloyd Hitchcock, Jr. *In its* Training of Radar Operators and Maintenance Personnel Jun. 1968 p 29–34 Presented at the American Physiol. Assoc., New York, Sep. 1957 (See N69-13132 03-05)
Avail: CFSTI

A five-stage research program resulting in Army adoption of an improved curriculum for M33 Antiaircraft Fire Control System maintenance mechanics is described. The sequence of research activities involved job analysis and definition, construction of a criterion test of maintenance proficiency, critical evaluation of the training program, using data obtained from the two preceding steps, development of two revisions of the training curriculum, and experimental tryout of the revised curricula. Author

N69-13161*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
**VISUAL SENSING OF SPACECRAFT GUIDANCE INFORMATION. EARTH ORBIT RENDEZVOUS MANEUVERS**
S. Seidenstein, W. K. Kincaid, Jr., G. L. Kreezer, and D. H. Utter Washington NASA Dec. 1968 257 p refs
(Contract NAS1-6801)
(NASA-CR-1214) Avail: CFSTI CSCL 06B

An analysis of each orbit rendezvous in terms of maneuver geometry served as a basis for establishing the requirements for visually sensed rendezvous guidance information. Analysis of the physical environment supported an evaluation of the sensory basis for visually deriving the desired information. Visual capabilities were then examined in terms of sensitivity, cross range motion perception, range, and range rate determinations. Estimates of sensitivity and variability are presented where available. Conclusions are drawn regarding the adequacy of available data, and recommendations are given for future areas of study. Author

N69-13198 Michigan Univ., Ann Arbor.
**PREDICTION OF ELEMENTAL MOTION PERFORMANCE USING PERSONNEL SELECTION TESTS**
Gary Kent Poock (Ph.D. Thesis) 1967 128 p
Avail: Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-17828

The purpose of this research was to investigate and develop a general methodology for predicting the level of performance an individual should be able to attain when working on a manual task. The predetermined time system of the Methods Time Measurement Association (MTM) was used as a measure of performance. The scope of the research was restricted to bench type assembly operations where physical strength and exertion were not limiting factors in performance of the job. Specifically it was proposed to use sensory, motor and psychomotor ability measurements of an individual as independent variables in regression equations to predict the time one would take to perform a basic Reach, Grasp, Move or Position motion of the MTM system. Testing apparatus were developed to measure: (1) the visual sense; (2) the kinesthetic sense; (3) the tactile sense; (4) forearm motor ability; (5) finger dexterity; (6) decision making ability; and (7) a person's recoding ability in approaching a problem. Dissert. Abstr.

N69-13202*# Webb Associates, Malibu, Calif.
**PRELIMINARY EVALUATION TEST OF THE LANGLEY CARDIOVASCULAR CONDITIONING SUIT CONCEPT**
B. V. Blockley and S. L. Friedlander Washington NASA Dec. 1968 70 p refs
(Contract NAS1-6004)
(NASA-CR-1206) Avail: CFSTI CSCL 06K

Two experiments were conducted, each two weeks in duration, in which the same subject spent the major portion of each day immersed in water and the remainder of the time in bed. The man remained completely horizontal except when submerged. In the control experiment, a simple waterproof garment was worn over ordinary long underwear during water immersion; in the second experiment the man was dressed in a specially constructed pressure suit designed to prevent or retard the deconditioning of weightlessness (cardiovascular conditioning suit or CVCS). The cardiovascular conditioning suit successfully prevented the deterioration in orthostatic tolerance, impairment in tolerance for brief mild exercise, and reduction in maximum work capacity which had been observed in the control experiment. During the initial 5 days, when pressurization time in the suit was less than one hour per day, venous compliance increased roughly 2-fold, but had fallen again to the initial value by the morning of the 11th day. Venous compliance appears to be an excellent predictor of tilt-table response. In the experiment in which the CVCS was used there was essentially no difference in venous compliance between pre- and

post-exposure, and the tilt responses were the same except for a slight elevation of diastolic pressures during the post-exposure tilt. Author

**N69-13223*#** Stanford Univ., Calif. Dept. of Applied Mechanics.
**PITCH AND YAW MOTIONS OF A HUMAN BEING IN FREE FALL**
M. P. Scher and T. R. Kane Sep. 1968 56 p refs
(Grant NGR-05-020-209)
(NASA-CR-97902; SU-TR-190) Avail: CFSTI CSCL 06S

Two limb maneuvers, one producing pitch motion, the other yaw motion, are analysed. Numerical results are given for representative examples. Author

**N69-13270** California Univ., Berkeley.
**A STUDY OF SIMULATION-AIDED ENGINEERING DESIGN**
Ian Irving Mitroff (Ph.D. Thesis) 1967 292 p
Avail: Univ. Microfilms: HC $13.30/Microfilm $3.75 Order No. 68-120

This is a case study of engineering design which analyzes the behavior of a particular design engineer before, during, and after the development and subsequent use of a new design aid. The study documents the improvement in the engineer's design performance resulting from his use of the aid, a computer simulation of the engineer's original design behavior. Improvement in performance is a result of the more extensive and systematic examination of alternate designs which the simulation has made possible. As a case study of engineering design, the study represents an intensive effort to identify and to model as many variables as possible affecting a particular engineer's development of a design project. Dissert. Abstr.

**N69-13407#** Princeton Univ., N. J. Dept. of Psychology.
**PERCEPTION OF DYNAMIC STIMULI Final Report, Sep. 1, 1963–Aug. 31, 1968**
Joseph M. Notterman, Ross D. L. Filion, and Frank J. Mandriota Sep. 1968 9 p refs
(Contract AF 49(638)-1258)
(AD-676289; AFOSR-68-1926) Avail: CFSTI CSCL 5/10

Stemming from considerations of a cybernetic nature, the program was directed towards a theoretical and empirical examination of the perception of changing stimuli. Representative stimuli were selected so as to fall into two classes: Kinetic (e.g., changing loudness and brightness), and topographic (e.g., expanding lines and circles; moving points). Both classes of stimuli were presented in such manner as to permit either continuous or discontinuous display, and in either of two modes: Isochronal (equal time for standard and comparison stimuli), or isometric (equal final magnitudes attained by standard and comparison stimuli). It is tentatively concluded that topographic displays are superior (i.e., are perceived more precisely) to kinetic, discontinuous (initial and final values only) are superior to continuous, and isochronal are superior to isometric. Author (TAB)

**N69-13446#** TRW Systems Group, Redondo Beach, Calif. Quantum Physics Lab.
**TRIPLET MATERIALS RESEARCH AND EYE-PROTECTIVE SYSTEM Final Report, 1 Dec. 1966–30 Jun. 1968**
W. R. Dawson and M. W. Windsor Jul. 1968 98 p refs
(Contract AF 41(609)-3201)
(AD-676724; TRW-07728-6005-R0-00; FR-8) Avail: CFSTI CSCL 6/17

The second prototype model of a 6 x 8-inch photochromic windshield segment has been developed, tested and delivered to the Air Force. The device is designed to protect Air Force Pilots against flash blindness resulting from viewing nuclear explosions. The reversible photochromic darkening is based upon the absorption of metastable triplet states of aromatic molecules. These compounds are incorporated into a transparent plate of epoxy plastic. Two plates are attached on the outside of a 6 x 8 x 1 1/2-inch quartz block and the triplet states are excited by uv light from two flash lamps. Black-glass filters absorb the visible light from the flash lamps which would otherwise dazzle the pilot. With a 3000J excitation flash the windshield segment darkens from an open-state absorbance of 0.06 to absorbances of 0.89, 1.68, 2.18 and 2.53, respectively, at times of 50, 100, 150 and 500 microseconds after the start of the flash. The open-state transmission, optical quality and rapidity of buildup of absorbance of the present device are greatly improved compared to the performance of the windshield segment developed on the preceding contract. The windshield segment reopens to half the closed-state absorbance in 1.6 seconds. Author (TAB)

**N69-13495#** Army Medical Research Lab., Ft. Knox, Ky.
**LASER PROPERTIES AND EYE HAZARDS Interim Report**
George R. Peacock and Frederick Van Nus 31 May 1968 28 p refs
(AD-676806; USAMRL-776) Avail: CFSTI CSCL 20/5

Eye injury is a recognized hazard of laser radiation. This report includes a basic discussion of those laser output parameters that are important in understanding lasers and how they are related to laser eye injury. The three most significant properties of laser beams in this respect are wavelength, time characteristics and beam geometry. The first two determine the site most susceptible to injury and its sensitivity to laser exposure dose. The third, beam geometry, essentially governs the distance at which a given laser is capable of producing a hazardous exposure condition. A brief description of experimental injury findings and some threshold exposure doses, as reported in the literature, are summarized. Laser safety considerations are discussed. Author (TAB)

**N69-13654#** Army Behavioral Science Research Lab., Washington, D. C.
**MONITORING PERFORMANCE AS A FUNCTION OF MUSCULAR RESPONSE EFFORT**
John G. Tiedemann and Richard N. Fail Jun. 1968 38 p refs
(AD-676834; BESRL-TRN-198) Avail: CFSTI CSCL 5/10

An exploratory study to determine the effect of requiring muscular effort in responding to signals as a means of improving monitoring performance is described. Author (TAB)

**N69-13698#** George Washington Univ., Alexandria, Va. Human Resources Research Office.
**A VIEW OF MAN'S ROLE AND FUNCTION IN A COMPLEX SYSTEM**
Francis H. Thomas Jun. 1968 15 p refs Presented at the Ala. Psychological Assn., Birmingham, Ala., May 1968
(Contract DA-44-188-ARO-2)
(AD-676777; PP-25-68) Avail: CFSTI CSCL 5/10

In this paper the roles and functions of man in the evolution and development of two complex specific systems within the Army operational environment are discussed. It is pointed out that throughout the course of historical development, the basic system functions and objectives have remained unchanged even though the system equipments have varied. With equipment changes, many physical functions in system operation have also changed. In predicting the effectiveness of man in a future system operational environment, an approach independent of equipment differences is required. Such an approach in which man is conceived as an information processor is described. The approach is applied to the human operator roles in manned aerial reconnaissance and surveillance and in target acquisition. Author (TAB)

**N69-13724#** Army Aviation Test Activity, Edwards AFB, Calif.
**SPECIAL STUDY OF AUTOROTATIONAL PROCEDURES**
**Final Report**
Kenneth R. Ferrell and John J. Shapley, Jr. Apr. 1968 27 p refs
(AD-676820) Avail: CFSTI CSCL 1/2

A limited investigation was conducted to evaluate the effects of maneuvering flight during autorotation and the flight characteristics during power recovery from autorotation. The testing consisted of 6.5 flight hours and was conducted from 11 December 1967 through 24 January 1968. The tests indicated that the existing method of presenting autorotation rate of descent information in the operators manual is not representative of the operational requirement. A maximum glide technique which utilizes low rotor speeds can be misleading, especially at high gross weights, in that rate of descent may increase, glide distance may decrease, and rotor energy will be less than optimum. The rapid increase in descent angle and rate of descent at speeds below 50 KIAS can be very deceptive. Altitude above the ground is probably the most important compensating factor during practice autorotations. Power recovery techniques are not particularly demanding at light weights but become extremely important at the limit gross weights.
Author (TAB)

**N69-13759#** George Washington Univ., Alexandria, Va. Human Resources Research Office.
**A BRIEF HISTORY OF AIRCRAFT IDENTIFICATION TRAINING**
Arthur C. Vicory Aug. 1968 15 p refs
(Contract DA-44-188-ARO(D)-2)
(AD-676791; HUMRRO-PP-27-68) Avail: CFSTI CSCL 5/9

The paper presents a selective review of previous and contemporary methods of teaching aircraft recognition to personnel manning forward area air defense weapons. Methods in use since about 1940, including the WEFT System (image-analysis concept), the Renshaw System (whole-image concept), the modified WEFT-Renshaw System (learning of aircraft features), and a method are examined. Research designed to coordinate studies of training with generalization, retention, and transfer in order to provide a better assessment of training effectiveness, is described.
Author (TAB)

**N69-13771#** Naval Aerospace Medical Inst., Pensacola, Fla.
**MANIKIN MEASUREMENTS OF THE NOISE ATTENUATION PROVIDED BY FLIGHT HELMETS**
John R. Forstall Aug. 1968 21 p
(AD-676885; NAMI-1049) Avail: CFSTI CSCL 6/14

Measurements of the noise attenuation provided by five flight helmets were obtained on a manikin head and compared with attenuation measurements obtained on human subjects according to the USASI Standard for Evaluating Real-Ear Attenuation at Threshold. The two sets of measurements were similar. The manikin method has certain advantages which should be considered in terms of the particular requirements of an evaluation program: (1) a helmet can be optimally fitted with little expenditure of time; (2) variability introduced by human factors is kept at a minimum; (3) high levels of noise can be used as the test stimulus; (4) visual and auditory monitoring of the attenuated noise provides the experimenter with a precise appraisal of the fit as adjustments are made; (5) manikin measurements are particularly useful in revealing improvements in attenuation resulting from minor modifications.
Author (TAB)

**N69-13774#** Texas Univ., Austin. Electronics Research Center.
**COMPUTER-AIDED INSTRUCTIONAL SYSTEM FOR TRANSMISSION LINE SIMULATION**
Erwin A. Reinhard 10 Jul. 1968 135 p refs
(Grant AF-AFOSR-766-67)
(AD-676278; TR-51) Avail: CFSTI CSCL 5/9

A computer-aided instructional system has been developed which utilizes dynamic computer-controlled graphic displays and which requires student interaction with a computer simulation in an instructional mode. A numerical scheme has been developed for digital simulation of a uniform distortionless transmission line with resistive terminations and arbitrary voltage sources at either or both ends of the line. The numerical transient and steady-state solution is exact independent of the number of spatial increments used to simulate the transmission line. The numerical solution provides data for an on-line CRT display unit which permits visual observation of the space-time dynamic behavior of the voltage and current waves. A computer-controlled audio tape recorder, a special keyboard, and special software for dynamic scope displays and for lesson programming have been developed as part of the instructional system. This system permits student interactions with a computer programmed lesson and associated laboratory simulations to create learning experiences which cannot be duplicated in the classroom or laboratory. The student interacts with the lesson by responding to multiple choice inquiries, by controlling the simulations, by making qualitative measurements of the dynamic variables directly on the scope face, and by constructing responses for subsequent judging by the computer. Two programmed lessons on transmission lines, each requiring about 45 minutes of student time, have been prepared and tested.
Author (TAB)

**N69-13788#** Applied Psychological Services, Wayne, Pa. Science Center.
**DEVELOPMENT OF PERFORMANCE EVALUATIVE MEASURES. PERSONNEL PSYCHOPHYSICS: TERMINAL THRESHOLD AND SIGNAL DETECTION THEORETIC APPLICATIONS TO PERFORMANCE ASSESSMENTS**
Arthur I. Siegel, M. A. Fischl, and Mark G. Pfeiffer Sep. 1968 62 p refs
(Contract N00014-67-C-0107)
(AD-676326) Avail: CFSTI CSCL 5/10

Two separate, but related, studies into the development of advanced techniques for performance and training evaluation are described. In the first study, the application of method of limits procedures to the evaluation of electronic trouble-shooting performance was investigated. The results indicated that the technique produced meaningful results and was sensitive to the level of training/experience of the technician and to different types of thinking. The second study demonstrated that application of variables derived from theory of signal detection possess merit for discriminating between groups at various levels of training/experience, for predicting academic success, and as tools for increasing academic and on-the-job performance ability.
Author (TAB)

# 06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

**N69-12614#** Library of Science, Washington, D. C. Aerospace Technology Div.
**ANOMALOUS WATER**
John Kourilo *In its* Foreign Sci. Bull., Vol. 4, No. 11 Nov. 1968 p 8-23 refs (See N69-12612 03-34)
Avail: CFSTI

Soviet theoretical and experimental studies of anomalous liquid water are reviewed in light of the bistructural molecular model of water. Thermodynamic calculations have shown that the disordered structure of water must be more stable than the ice-like structure. The question of why all water is not readily available in disordered state has been answered. Experimental proof of the existence of anomalous water was offered in studies of the growth of condensed water columns in glass or quartz capillaries. Anomalous physical properties of water in capillary columns and thin films were determined. A reversible polymorphic phase transition $\alpha \rightleftarrows \beta$ was detected in the disordered liquid state in capillary columns. An experimental procedure was developed to prepare anomalous water in capillary columns in quantity sufficient to continue the study of its properties and structure. The importance of anomalous water studies in biological and chemical industrial processes, and atmospheric phenomena was noted. Author

**N69-12620** State Univ. of Iowa, Iowa City.
**VAPORIZATION, THERMODYNAMICS, AND DISSOCIATION ENERGY OF YTTRIUM MONOSULFIDE**
Roger Arthur Steiger (Ph.D. Thesis) 1967 114 p
Avail: Univ. Microfilms: HC $5.60/Microfilm $3.00 Order No. 67-16845

The dissociation energy, heat and entropy of sublimation, and heat of formation of yttrium monosulfide were determined from the measurement of the total rate of mass effusion of the monosulfide and mass spectrometric effusion studies of the evaporating species. The preparation of the monosulfide was accomplished in a specially designed apparatus in which the finely divided metal was reacted with hydrogen sulfide at reduced pressures at approximately 1100°C, and then heated in vacuum at 1750 to 1850°C. X-ray analyses showed that the lattice parameter for the NaCl-type structure of YS increased on prolonged heating in vacuum at high temperatures to a maximum, $a_o = 5.4873 \pm 0.0004$A. The Faraday method was used to determine the molar magnetic susceptibility of YS. Absolute rates of effusion of yttrium monosulfide from a tungsten cell in vacuum were measured in the temperature range 2097 to 2352°K. Dissert. Abstr.

**N69-12633** Texas Univ., Austin.
**MOESSBAUER SPECTROSCOPIC DETERMINATION OF THE ELECTRIC FIELD GRADIENT TENSOR AT THE IRON SITE IN IRON-BEARING COMPOUNDS**
John Carlton Travis (Ph.D. Thesis) 1967 155 p
Avail: Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 68-4350

The electric field gradient (efg) tensor evaluated at the iron nucleus in iron compounds contains important chemical information. This information concerns the arrangement of the ligands about the iron atom, or the characteristics of the iron-ligand bonds, or both. The efg tensor is characterized by two independent parameters. These parameters both vanish at a point if the distribution of charge about that point has cubic symmetry. The measurement of the efg parameters at the iron nucleus in iron compounds is the subject of this work. Ordinarily, samples consist of randomly oriented crystallites, and no additional information about the efg tensor is available from normal Mössbauer spectra. Large magnetic fields were used for splitting the residual degeneracies, and hence revealing additional information from which the efg parameters could be extracted. Idealized theoretical spectra have verified that the values of both parameters are reflected in the shape of such magnetically perturbed spectra. Dissert. Abstr.

**N69-12647** Stevens Inst. of Tech., Hoboken, N. J.
**THE RADIATION CHEMISTRY OF GASEOUS AMMONIA**
Jens Thuroe Carstensen (Ph.D. Thesis) 1967 151 p
Avail: Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 68-1155

Substantiation of a detailed reaction mechanism which throws a new light on the general mechanism of radiolysis of ammonia is presented. Aside from excitation and ionization, the occurrence of $NH_4^+$ has prevously been demonstrated, but the data reported here, in conjunction with energetic requirements and with recently published mass spectrometry data makes the inclusion of $NH_2^+$ a necessity. Scavenging experiments have led to determination of a previously unreported rate constant for the gas phase reaction of nitrogen hydrides. Dissert. Abstr.

**N69-12691** Utah Univ., Salt Lake City.
**SURFACE CHEMISTRY OF THORIA GEL**
Charles Stanley Olsen (Ph.D. Thesis) 1967 128 p
Avail: Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 67-17558

A surface study of thoria gel based upon results of an in situ infrared technique indicated six possible forms of surface water, two forms were adsorbed as molecular water and four as surface hydroxyl groups. One of the two forms of molecular water was physically adsorbed and easily removed while the other was strongly bonded, possibly to surface nitrates. Of the four types of surface hydroxyl groups indicated, one appeared to be non-hydrogen bonded, two were unique and appeared as rather monochromatic states, and the fourth form apparently involved hydrogen bonding with surface nitrates. Infrared evidence also indicated covalently bonded surface carbonate probably due to $CO_2$ adsorption from the atmosphere during the preparation of thoria gel. Upon heating thoria to 300°C under vacuum, the thoria gel turned from a white color to completely black. This discoloration was attributed to a defect state in thorium oxide. However, it may be due to residual carbon formed by decomposition of surface carbonates. Dissert. Abstr.

**N69-12698** Minnesota Univ., Minneapolis.
**HELIUM-6 PRODUCTION IN LOW ENERGY LITHIUM-7 REACTIONS**
Robert Anthony Stryk (Ph.D. Thesis) 1967 72 p
Avail: Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 68-1570

The absolute angular distribution of helium-6 produced by 3.0, 3.5, and 3.8 MeV lithium-7 upon lithium-7, boron-10 and boron-11 was measured. The helium-6 was detected by its beta decay in a chopped beam experiment. In a chopped beam experiment the beam is periodically turned on and off. The events which occur when the beam is off are analyzed. The theory of chopped beam experiments is derived. A computer program for non-linear least squares curve fitting is described. Dissert. Abstr.

**N69-12735** Virginia Polytechnic Inst., Blacksburg.
**GAS CHROMATOGRAPHIC ANALYSIS OF SOLID STATE REACTIONS**
John Wendel Neidhardt, Jr. (Ph.D. Thesis) 1967 125 p
Avail: Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 68-2063

Applicability of using a process gas chromatograph to study the reaction rate of a solid state material was investigated. Evaluations were made on the basis of the apparent activation energy calculated from results. Calcium carbonate with and without an addition of silica was used in the investigation. $CaCO_3$, $CaCO_3 + 1SiO_2$, $CaCO_3 + 2SiO_2$, and $CaCO_3 + 3SiO_2$ at temperatures of 750, 777, and 800°C were studied. Three repetitions of each sample mixture at each temperature were made and the results analyzed to produce rate curves and activation energies. A first order reaction was found to adequately describe the reaction.

Apparent activation energy was found by applying area integration to the chromatograms obtained. The activation energy found for $CaCO_3$ was found to be 45.1 ± 2.7 kilocalories and varied for samples containing silica (quartz). Dissert. Abstr.

**N69-12737** State Univ. of Iowa, Iowa City.
**DIFFUSION OF INERT GASES IN OLIVE OIL**
John Anthony Stitzell (Ph.D. Thesis) 1967 114 p
Avail: Univ. Microfilms: HC $5.60/Microfilm $3.00 Order No. 68-987

The diffusivities of argon, krypton and xenon in olive oil were measured at one atmosphere at 25°C, 30°C, and 37°C. The volume of gas adsorbed by a stagnant oil sample was measured to determine the sorption curve for each case. Diffusivity was determined by appropriate curve-fitting analysis of the sorption curves. The diffusivities obtained showed precise agreement to within 2.7% experimental error. Another experimental technique was developed to measure the diffusivity using a radioactive isotope as a tracer. The apparatus measured the intensity of radiation at various points as diffusion progressed down the length of a capillary tube. The diffusivity of krypton, using $Kr^{85}$ as a tracer, was measured at one atmosphere and 25°C utilizing this technique. The result, when compared with the result from the sorption technique, indicated that this was a valid approach to measure diffusivity. Dissert. Abstr.

**N69-12738** State Univ. of Iowa, Iowa City.
**TRANSIENT DIFFUSION OF GASES IN POROUS GLASS**
William Robert Brade (Ph.D. Thesis) 1967 66 p
Avail: Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 68-903

Adsorption rates of carbon dioxide and propane on a porous Vycor slab one cm. thick were measured at 0, 25, and 50°C., and pressures of 0.25, 0.50, and 0.75 atm. Adsorption rates of ethane and n-butane at the same pressures were measured at 0°C. and 50°C. respectively. The Knudsen diffusion coefficients were estimated from steady-state flow measurements. The contribution of surface diffusion to the effective diffusion coefficient was significant for all of the experimental tests. Some of the above experiments were repeated using a slab with a thickness of two cm. in order to study the effect of thickness on the diffusion rate. While the results were inconclusive, it may be said that the diffusion coefficient was concentration-dependent for some of the experimental conditions. It was shown that the equation proposed by Liszi can be derived from Langmuir's adsorption rate equation. The former equation was used to correlate absorption rates which were not diffusion-controlled. Dissert. Abstr.

**N69-12746#** Iowa State Univ. of Science and Technology, Ames.
**LOW TEMPERATURE SPECIFIC HEAT OF SOME CERIUM AND LANTHANUM LAVES PHASE COMPOUNDS**
Robert Roderick Joseph (Ph.D. Thesis) May 1968 76 p refs
(Contract W-7405-eng-82)
(IS-T-228) Avail: CFSTI

The low-temperature properties of the Laves phase compounds $CePt_2$, $CeRu_2$, $LaPt_2$, and $LaRu_2$ have been measured. Both of the ruthenium compounds have large values of $\gamma$ and values of $\theta_D$ near those of the rare earth metal. The value of $\theta_D$ for $LaPt_2$ has been measured and found to be close to the $\theta_D$ for platinum. Also, $\theta_D$ for $CePt_2$ has been inferred, by comparing the specific heats to be not much smaller, if any, than that for $LaPt_2$. Thus it appears that for the ruthenium compounds it is the rare earth atoms which are giving the lattice its rigidity, i.e., rare earth-rare earth contacts, and in the case of the platinum compounds it is transition metals. The fact that the $\gamma$ values of the ruthenium compounds are large compared to $LaPt_2$ indicates that large band structure effects occur in these compounds which might serve to explain the order of the compounds. NSA

**N69-12844** Rensselaer Polytechnic Inst., Troy, N. Y.
**A PROTON TRANSFER THEORY OF THE HETEROGENEOUS ATTACK OF PURE METALS BY WEAK ORGANIC ACIDS**
Bruce Robert Wright (Ph.D. Thesis) 1967 117 p
Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 68-850

The heterogeneous reaction between zinc and air free, buffered, dilute acetic acid solutions was studied from several viewpoints: (1) The extent to which slow diffusion limited the reaction rate was determined. (2) A probable mechanism for the reaction was determined. (3) The influence of some organic additives was used to help determine the reaction mechanism and in this portion corrosion inhibition was demonstrated. An isothermal, tubular, differential reactor was used with acetic acid solutions in laminar flow at 23°C to determine the extent to which slow diffusion limited the reaction rate. For acid concentrations from $1\times10^{-1}$ moles/liter to $1\times10^{-3}$ moles/liter and pH from 6.0 to 4.3 the influence of diffusion was found to be very small. A Reynolds number range of 50 to 800 was used in this work. Dissert. Abstr.

**N69-12852** Stevens Inst. of Tech., Hoboken, N. J.
**SUBSTITUENT EFFECTS IN NUCLEAR MAGNETIC RESONANCE**
Theodore Vladimiroff (Ph.D. Thesis) 1967 169 p
Avail: Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 68-1164

This investigation was motivated by the observation that certain spin–spin coupling constants are directly additive whereas others are pairwise additive with respect to substituent groups. During the study it was found that the directly bonded C–F, Si–H and Sn–H and nondirectly bonded Sn–H couplings are pairwise additive. A simple model consisting of two noninteracting electrons confined to a one-dimensional, square-well potential was used to test the perturbation method employed in spin-coupling calculations. This study shows that the Ramsey theory correctly treats the one-dimensional analogue of the Fermi contact mechanism, at least for this simple case. Dissert. Abstr.

**N69-12853** California Univ., San Diego.
**THEORETICAL AND EXPERIMENTAL STUDIES OF NMR COUPLING CONSTANTS**
Gary Carl Graham (Ph.D. Thesis) 1967 88 p
Avail: Univ. Microfilms: HC $4.60/Microfilm $3.00 Order No. 68-1135

Contact contributions to H–H, $C^{13}$–H, and $C^{13}$–$C^{13}$ coupling constants in a selection of hydrocarbons are calculated according to the molecular orbital theory developed by Pople and Santry using one-electron wave functions and energies generated according to the extended Hückel theory. Spin-orbit and spin-dipolar contributions are also calculated for the directly bonded $C^{13}$–$C^{13}$ couplings for ethane, ethylene, and acetylene. Results are shown to be in semi-quantitative agreement with experiment for most types of coupling. Calculated values of directly bonded $J_{C13-H}$ correlate with the observed values but are uniformly low by a factor of about 1.5. For coupling through two bonds, both $J_{HH}$ and $J_{C13-H}$ are calculated to be negative in all the examples studied. This is in agreement with experiment for most saturated hydrocarbons but is in serious error for ethylene and acetylene. Calculated vicinal H–H couplings follow observed values in most of the cases studied. Dissert. Abstr.

**N69-12872** Washington State Univ., Pullman.
**POLAROGRAPHIC REDUCTION OF OXYGEN IN APROTIC SOLVENTS**
Edward Lee Johnson (Ph.D. Thesis) 1967 74 p
Avail: Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 68-701

The reduction of oxygen in the aprotic solvents dimethylsulfoxide (DMSO) and N,N-dimethylformamide (DMF) has

been shown to proceed through two steps at the dropping mercury electrode. The first step is due to the reaction $O_2 + e = O_2^-$. The second wave is not as high as the first, but has been represented by the reaction $O_2^- + e^- + \text{cation} = \text{peroxide product}$. The two reduction waves have been shown to be shifted markedly by changes in the cation present in the supporting electrolyte. The height of the second wave changes with change of cation in the supporting electrolyte. The diffusion coefficient of oxygen in DMSO and DMF has been calculated from the data obtained. In solutions containing both oxygen and one of the following metal ions $Zn^{+2}$, $Sr^{+2}$, $Tl^{+}$, $Y^{+3}$, $Cd^{+2}$, $Co^{+2}$, a new polarographic reduction wave was observed at potentials less cathodic than that required to reduce the most easily reducible species (either the metal ion or the oxygen) in the sample. Dissert. Abstr.

**N69-12873** Minnesota Univ., Minneapolis.
**OPTICAL AND ELECTRICAL PROPERTIES OF SOME GROUP IV DISULFIDES**
Kyu Chang Park (Ph.D. Thesis) 1967 130 p
Avail: Univ. Microfilms: HC $6.20/Microfilms $3.00 Order No. 68-1558

Large single crystals of $TiS_2$, $ZrS_2$, $HfS_2$, and $SnS_2$ have been prepared by the chemical vapor transport technique, using iodine as the transporter. All four disulfides were found to be n-type semiconductors with $CdI_2$ (C6) structure. The optical energy gap values were 1.72, 2.02, and 2.24 eV, respectively, for $ZrS_2$, $HfS_2$, and $SnS_2$. The energy gap values measured from the conductivity curves were 2.1 eV for $HfS_2$ and 2.2 eV for $SnS_2$. Measurements were made of the reflectivity between 1 and 12 eV and of the transmission in the low energy region below the energy gap. The optical constants n and k were determined utilizing the Kramers–Kronig dispersion relation. From the study of the temperature dependence of conductivity the electrical properties of the compounds were found to vary from near metallic $TiS_2$ to near insulating $SnS_2$. Room temperature conductivity values were $1.4 \times 10^3$, $7.6 \times 10^{-1}$, $3.0 \times 10^{-8}$, and $9.6 \times 10^{-9}$ ohm$^{-1}$cm$^{-1}$, respectively, for $TiS_2$, $ZrS_2$, $HfS_2$, and $SnS_2$. Dissert. Abstr.

**N69-12874** Arizona Univ., Tucson.
**THE PREPARATION AND SPECTRAL INVESTIGATIONS OF NEW NITROSYLS OF IRON AND CHROMIUM**
William Eugene Silverthorn (Ph.D. Thesis) 1967 209 p
Avail: Univ. Microfilms: HC $6.00/Microfilms $3.00 Order No. 68-1023

The spectral properties of the o-phenylenebis(dimethylarsine), das, and cis-ethylenebis(dimethylarsine), edas, complexes $[Fe(das)_3]^{2+,3+}$, $[Fe(edas)]^{2+,3+}$, $[FeX_2(das)_2]^{0,1+}$, $[CrX_2(das)_2]^{1+}$, where X is a halogen, and $[Co(das)_3]^{3+}$, are measured and interpreted on the basis of ligand field theory. The preparation and investigation of several new nitrosyl complexes of iron and chromium are described. These nitrosyl complexes are of the type $[CrXNO(das)_2]^{0,1+}$, and $[FeXNO(das)_2]^{1+,2+}$ in which X is a halide. Measurements of the infrared spectra, conductances in solution, magnetic susceptibilities, and X-ray powder patterns have established that the cations are monomeric with the coordinated nitrosyl group trans to the halide. The properties of these complexes are conveniently interpreted in terms of a complex in which $(N=O)^{-}$ is bonded to the metal. Dissert. Abstr.

**N69-12875** North Carolina Univ., Chapel Hill.
**THE CHEMISTRY OF SULFUR-CONTAINING PEPTIDES. PART 1: RACEMIZATION STUDIES OF CYSTEINE PEPTIDES. PART 2: SYNTHESIS OF CROSS-LINKED PEPTIDES**
Gerald Wayne Davis (Ph.D. Thesis) 1967 209 p
Avail: Univ. Microfilms: HC $9.45/Microfilm $3.00 Order No. 68-2171

A general method for determining the degree of racemization associated with the synthesis of cysteine peptides was developed. Racemization was determined by the enzymatic hydrolysis of the fully protected cysteine peptide derivatives using leucine aminopeptidase and aminopeptidase M. The synthesis of cyclic cystine peptides containing more than one disulfide bond was accomplished. Cysteine peptides containing selectively removable sulfur protective groups were synthesized and converted to cyclic bis-disulfides by stepwise disulfide formation using the sulfenylthiocyanate method. A symmetrical bis-disulfide and an unsymmetrical-antiparallel bis-disulfide were prepared using the sulfenylthiocyanate method in conjunction with the S-trityl, S-benzhydryl, and S-benzoyl groups. The symmetrical bis-disulfide in N,N-dimethylformamide was found to be converted to the stabler cyclic monomer disulfide; this conversion was found to be temperature dependent. Dissert. Abstr.

**N69-12891#** Kernforschungsanlage, Juelich (West Germany). Zentrallabor fuer Chemische Analyse.
**MODERN POLAROGRAPHIC TECHNIQUES USED IN STUDIES OF THE KINETICS OF FAST CHEMICAL AND ELECTROCHEMICAL STEPS IN PROTON TRANSFER PROCESSES ON A MERCURY ELECTRODE [STUDIEN MIT MODERNEN POLAROGRAPHISCHEN TECHNIKEN ZUR KINETIK SCHNELLER CHEMISCHER UND ELEKTROCHEMISCHER SCHRITTE VON PROTONENTRANSFERPROZESSEN AN DER QUECKSILBERELEKTRODE]**
Hans Wolfgang Nuernberg Dec. 1967 407 p refs In GERMAN (JUEL-475-CA) Avail: CFSTI

Electrochemical methods of a polarographic nature were employed to: (1) investigate the dissociation and recombination kinetics of partially dissociated acids in aqueous solution; (2) study experimentally and theoretically the effects of the double layer on the homogeneous proton transfer processes in the boundary layer of electrode/solution; and (3) study the processes that determine the speed of the surface reaction during hydrogen separation on the mercury electrode, especially in the very negative ranges of the electrode potential. The study also aims to demonstrate the exceptionally good possibilities offered by these modern polarographic techniques for investigating electrochemical kinetics, even those of very fast reactions. Transl. by K.W.

**N69-12892** Wisconsin Univ., Madison.
**STEREOCHEMISTRY AND EXCITED STATES**
George Charles Licke (Ph.D. Thesis) 1967 101 p
Avail: Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 67-10638

Zimmerman and Wilson observed the photoisomerization of *cis*- and *trans*-5,6-diphenylbicyclo(3.1.0) hexan-2-one. It was suggested that through the use of optically active reactant one could determine whether internal or external bond cleavage of the cyclopropane ring is involved in the photoisomerization. Following this suggestion, *trans*-5,6-diphenylbicyclo(3.1.0) hexan-2-one was resolved and photolyzed. It was found that photoisomerization of the *trans*-isomer proceeds completely by external bond cleavage; whereas, photoisomerization of the *cis*-isomer proceeds by both pathways, 85% by external bond cleavage and 15% by internal bond cleavage. Dissert. Abstr.

**N69-12903#** Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
**FIXATION OF RADIOACTIVE RESIDUES; RESEARCH AND DEVELOPMENT ACTIVITIES Quarterly Progress Report, Nov. 1967–Jan. 1968**
A. M. Platt, ed. Jul. 1968 41 p refs *Its* Radioact. Waste Res. and Develop. Activities Rept. No. 35
(Contract AT(45-1)-1830)
(BNWL-771) Avail: CFSTI

During pot calcination Run PC-6, 1,300,000 Ci of radioactivity was processed in an 8-in. pot. The 5100 W of heat generated by this radioactivity was sufficient to produce a maximum calcine temperature of 940°C at the pot centerline, and a pot centerline to wall $\Delta T$ of 700°C with the pot heating in air. Approximately

2,000,000 Ci of radioactive waste was successfully processed in the first three radioactive phosphate glass runs in Waste Solidification Engineering Prototypes (WSEP). These demonstrations represented the first conversion of highly radioactive wastes into glass on an engineering scale. Non-radioactive development work on spray solidification indicated that (1) batch dumping of a PW-2 melt into an unheated mild steel container is feasible, and (2) the filterability of the calcine from a PW-1 in-pot melting flowsheet is greatly improved by adding a portion of the $NaPO_3$ to the feed, as compared to the previously used technique of adding all the flux in solid form to the melt pot. Author (NSA)

**N69-12939** Cincinnati Univ., Ohio.
**STATISTICAL CHARACTERIZATION OF A CHEMICAL REACTOR**
Larry Clinton McCune (Ph.D. Thesis) 1967 404 p
Avail: Univ. Microfilms: HC $18.25/Microfilm $5.15 Order No. 68-2011

Statistical correlation theory was experimentally applied to the "efficient" identification of the process dynamics of a real chemical reactor. A continuous-flow stirred-tank reactor was used in which an irreversible, second-order reaction was simultaneously forced by more than one random input. Since the proposed reactor system was composed of several physical processes, and the reactor variables were measured by more or less complicated transducers, characterizations were made not only of the overall reactor behavior, but also of the dynamic behavior of the individual components comprising the system. A realistic identification scheme (Input-Compensated Modeling) was proposed and tested. A low-cost forcing function generator was designed and developed. Characterizations were made of both thermal-mixing and mass-mixing systems. Two modes of isothermal reactor operation were studied by simultaneously perturbing the input concentrations of the two reactants. Dissert. Abstr.

**N69-12958#** Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
**MEASUREMENT OF THE PERMEABILITY OF METALS TO HYDROGEN AT ROOM TEMPERATURES**
Arthur H. Dexter Apr. 1968 16 p refs
(Contract AT(07-2)-1)
(DP-1108) Avail: CFSTI

Previous measurements of hydrogen permeation of metals have been limited to high temperatures where permeation rates are relatively high and pressure-sensing devices can be employed to measure the permeating gas. Permeation rates at room temperature can be measured by the use of tritium (the radioactive isotope of hydrogen) and conventional counting equipment. With the equipment and techniques described in this report, it is possible to measure hydrogen permeation rates on the order of $10^{-17}$ $cm^3$ (STP)/(sec) ($cm^2$) per mm thickness of metal. Author (NSA)

**N69-13025#** European Atomic Energy Community, Ispra (Italy) Physical Chemistry Branch.
**MECHANICAL RELAXATION PEAKS IN NIOBIUM DUE TO HYDROGEN AND DEUTERIUM**
P. Schiller and A. Schneiders *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 871-880 refs (See N69-12994 03-17)
Avail: CFSTI

Measurements of the internal friction of niobium charged with different amounts of hydrogen and deuterium revealed a relaxation peak for frequencies in the Kc-range at temperatures around 100°K. The relaxation time for the peak due to the hydrogen in solution is about 100 to 300 times shorter than the relaxation time observed in the case of the deuterium solution. The activation energies are about 0.15 eV for Nb-H and 0.18 eV for Nb-D. The height of the peak supports the model, that the hydrogen atoms are located in the tetrahedral sites of the bcc lattice. Author

**N69-13084** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**OPTICAL AND INFRARED SPECTROSCOPY**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 25-35 refs (See N69-13060 03-34)
(Contracts DA-28-043-AMC-02536(E); AF 19(628)-6066)
Avail: CFSTI

The reflection spectra of $CdS_xSe_{1-x}$ for several values of x were remeasured. In the reststrahlen spectra of $Cd_xSe_{1-x}$, the infrared active phonons occur in two main bands with frequencies near those of pure CdS and pure CdSe which is characteristic of a system in which short range forces influence the lattice dynamics. The system studied neither behaves as ionic mixed crystals nor entirely as covalent mixed crystals. The present investigation, which includes Raman measurements, revealed the behavior of both k ≈ 0 LO (long wavelength longitudinal optic mode) and TO (transverse optic mode) phonons as functions of x. Seven mixed crystals were investigated in the concentration range $0.07 < x < 0.71$; all measurements were made on unoriented crystals. The reflection, Raman and far infrared transmission spectra curves are depicted and analyzed. B.P.

**N69-13081#** Kansas State Univ., Manhattan. Dept. of Chemistry.
**LOW ENERGY ELECTRON IRRADIATION OF SOLID ETHENE AT 63° K**
P. S. Gill and H. D. Moser 1967 16 p refs
(Contract AT(11-1)-584)
(COO-584-36) Avail: CFSTI

Films of solid ethene at 63° K were irradiated with electrons at 8.7, 18.7, 28.7, and 48.7 eV. The major products were $H_2$, $C_2H_2$, $C_2H_6$, $n\text{-}C_4H_{10}$, $1\text{-}C_4H_{10}$, $2\text{-}C_4H_8$. The product yield increased sevenfold as the energy was increased from 8.7 to 48.7 eV, but the relative yields of the products remained constant at all energies. The two compounds $C_2H_2$ and $C_2H_6$ accounted for a little more than three-fourths of the hydrocarbon products. The presence of NO, at a mole fraction of 0.15 or more, greatly reduced the yields of $C_2H_6$ and $n\text{-}C_4H_{10}$ but had little effect on the yields of $C_2H_2$ and $2\text{-}C_4H_8$. Decomposition of excited ethene to form $C_2H_2$ and $H_2$ or 2H is proposed as the most important initial process. Author (NSA)

**N69-13094#** Bhabha Atomic Research Centre, Bombay (India). Chemistry Div.
**DIFFUSION OF MOLYBDENUM AND CERIUM IN BETA-ZIRCONIUM**
A. R. Paul, M. S. Anand, M. C. Naik, and R. P. Agarwala *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 105-119 refs (See N69-13085 03-17)
Avail: CFSTI

Diffusion of molybdenum and cerium in beta zirconium has been studied by residual activity technique in the temperature range of 880°-1600°C. The results thus obtained show a non-linearity in the plots showing temperature dependence of diffusivities as observed in the self and impurity diffusion of niobium and vanadium in beta-zirconium and low values of $D_o$ and Q in the low temperature range. On the basis of dual mechanisms operating, the diffusivities (D $cm^2$/sec) in the above cases could be expressed as a sum of two exponentials. The non-linearity in the Arrhenius plots has been explained on the basis of i) extrinsic defects being introduced by the presence of residual impurities, ii) enhancement due to the randomly oriented dislocations and iii) vacancy-divacancy model. Author

**N69-13137#** Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
**EXTRACTION STUDIES OF CERIUM(III) INTO DI-(2-ETHYLHEXYL)PHOSPHORIC ACID AND THE OBSERVATION OF ITS OXIDATION IN THE PRESENCE OF CONCENTRATED NITRATE SOLUTIONS TO FORM A Ce(IV)-NITRATE-DEHP COMPLEX**

L. A. Bray and J. A. Partridge Sep. 1968 18 p refs Presented at 5th Intern. Conf. on Solvent Extraction Chem., Jerusalem, 16–18 Sep. 1968
(Contract AT(45-1)-1830)
(BNWL-SA-1447; CONF-680913-1) Avail: CFSTI

Recent studies showed that a yellow Ce(IV) complex was obtained when Ce(III) was extracted by HDEHP and then washed with high nitrate concentrations (6 to 7M) of various inorganic salt solutions [Na(I), Sr(II), Ce(III), or Al(III)], or when Ce(III) was extracted directly from these concentrated nitrate solutions. When Ce(III) was extracted into HDEHP from very dilute nitrate solutions or from solutions containing anions, the organic phase remained colorless. Since the oxidation potential of the Ce(III)–Ce(IV) couple is −1.61 volts, this observation of cerium oxidation in the presence of high nitrate solutions and HDEHP appeared worthy of further study. The solvent extraction of cerium with HDEHP and the formation of Ce(IV) as a function of nitrate, HDEHP, metal cation, and hydrogen ion concentration is discussed. The Ce-DEHP compound resulting from the extraction of Ce(III) from high nitrate solutions was prepared and compared with that of Peppard and Ferraro through elemental analysis, ir spectrometry, and vapor pressure osmometry. NSA

**N69-13139** Kansas Univ., Lawrence.
**DIRECT AND RARE GAS SENSITIZED RADIOLYSIS OF LIQUID PROPANE**
Robert D. Koob (Ph.D. Thesis) 1967 145 p
Avail: Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 68-596

A study of the gamma radiolysis of liquid propane was undertaken. A principal objective was to see to what extent the mechanisms found for the gas phase radiolysis of propane can be extended to the liquid phase radiolysis. Of primary interest was the establishment of ionic reactions in the liquid hydrocarbon. To this end radical scavengers and rare gas sensitizers were employed. Direct evidence for the presence or absence of bimolecular reactions in the liquid was obtained by analysis of irradiated mixtures of perproto- and perdeuteropropane. Gas chromatography was used both to purify the reactant propane and to analyse the irradiated sample. Mass spectrometry was employed as an analytical tool for determining the relative amount of various isotopic distributions of products formed in the radiolysis of systems such as $C_3H_8$–$C_3D_8$–$O_2$. Dissert. Abstr.

**N69-13148#** Technische Hochschule München (West Germany). Institut fuer Radiochemie.
**STUDY OF PHOTO-VOLTAIC CONVERSION [UNTERSUCHUNGEN ZUR PHOTOVOLTAISCHEN KONVERSION]**
K. Lorenzen and H.-J. Born Mar. 1968 24 p refs In GERMAN; ENGLISH summary
(BMwf-FBK-68-07) Avail: CFSTI

The behavior of $^{147}Pm$–ZnS luminous compounds was investigated. Mechanical and chemical treatments yielding a change in luminosity were investigated by exciting the ZnS by an external $\beta$-emitting source. The $^{147}Pm$ luminous compounds show an effect of aging, which was investigated and compared with the aging by irradiation with $^{60}Co$ $\gamma$ rays. The absolute values of the luminosity were determined up to 25 Ci $^{147}Pm$/g ZnS. Author (NSA)

**N69-13192** Purdue Univ., Lafayette, Ind.
**A MASS SPECTROMETRIC STUDY OF THE ANGULAR DISTRIBUTION OF MOLECULAR EFFUSION**
David Warren Muenow (Ph.D. Thesis) 1967 174 p
Avail: Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 67-16686

To determine the effect of molecular structure upon effusive flow, the angular distributions of structurally dissimilar vapor species emitting from cylindrical orifices have been measured. The experimental apparatus consisted of a high temperature Knudsen cell assembly capable of rotation about an axis contained within the plane of the outer face of the orifice. This unit was mounted on a 60° sector field, 30.5 cm. radius-of-curvature, first-order, direction-focusing mass spectrometer. The system chosen for study was finely divided KCl in a temperature range extending from 570° to 610°C; the principal vapor species above KCl(s) are KCl(g) and $K_2Cl_2$(g). Contrary to the theory of Clausing which predicts that the angular distribution should be dependent only upon the length-to-radius ratio of the effusion orifice in the low pressure region of molecular flow, the experimental evidence shows that in addition to the geometric factor the spatial distributions are highly dependent upon the physical characteristics of the effusing molecular specie and also the source pressure behind the orifice. Dissert. Abstr.

**N69-13193** Catholic Univ. of America, Washington, D. C.
**THE HYDROGEN ATOM ADDITION TO OLEFIN MOLECULES AT CRYOGENIC TEMPERATURES**
Richard David Kelley (Ph.D. Thesis) 1967 99 p
Avail: Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-17130

A technique has been developed by which the hydrogen atom addition to olefin molecules can be studied in great detail. The hydrogen atoms, generated on a hot filament, were allowed to impinge on a film of olefin condensed at cryogenic temperatures (below 150°K). It is shown unequivocally that the addition reaction takes place at the surface, and does not occur in the bulk of the film. The surface concentration of the olefin is replenished by diffusion from the interior of the film. The alkyl radicals formed at the surface either diffuse into the interior and are depleted solely by reaction with other radicals, or remain on the surface long enough to react with hydrogen atoms. Since the fate of the radical is dependent on diffusion conditions in the matrix, it has been possible to isolate for detailed study the disproportionation and combination reactions of alkyl radicals 1) with alkyl radicals and 2) with hydrogen atoms. Dissert. Abstr.

**N69-13196** Arizona Univ., Tucson.
**THE EFFECT OF HYDROSTATIC PRESSURE ON THE SELF DIFFUSION RATES IN NON-CUBIC SYSTEMS**
David Lee Styris (Ph.D. Thesis) 1967 39 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-784

The self diffusion rates along the principal axes in zinc were measured by the method of tracer-lathe sectioning at 410°C and at hydrostatic pressures form 2.00 to 9.00 kilobars. Anisotropies in the diffusion-rate and in the variation of the diffusion rate with pressure were observed. The activation volumes for diffusion in the directions perpendicular and parallel to the c-axis were determined to be 5.77 ± 0.52 and 3.70 ± 0.40 $cm^3$/mol, respectively. Analysis of the pressure data indicates that the diffusion is probably controlled by two vacancy mechanisms, and that the activation volume for diffusion in the basal-plane is 6.01 $cm^3$/mol. Limits on the magnitude of the dilation of the nearest neighbors of the atoms in the activation states were determined. A technique to measure diffusion in brittle metals such as bismuth, and which provides sections as small as 100 angstroms thick was developed. Dissert. Abstr.

**N69-13220*#** Rocketdyne, Canoga Park, Calif.
**INFRARED SPECTRAL ABSORPTION COEFFICIENT DATA FOR WATER**
W. F. Herget and J. S. Mukhead 28 Jan. 1968 46 p refs
(Contracts NAS8-20397; NAS8-19)
(NASA-CR-98160; R-7358) Avail: CFSTI CSCL 07B

A summary of a spectral absorption coefficient measurements program is presented. The data are for water vapor in the 1 to

8 micron region over the temperature range 575 to 1250 degrees Kelvin at pressures up to 1 atmosphere. Foreign gas broadening by $H_2$, Cl, and $CO_2$ is included. An index to the available spectra is reproduced as an appendix. Author

N69-13244# Technische Hochschule Munchen (West Germany). Institut fuer Radiochemie.
**THE ISOLATION OF Cm-242 IN THE 100-Ci REGION FROM NEUTRON-IRRADIATED Am-241 [DIE ISOLIERUNG VON Cm-242 IM 100 Ci-BEREICH AUS NEUTRONENBESTRAHLTEM Am-241]**
H.-J. Born and G. Hoehlein Mar. 1968 33 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-68-10) Avail: CFSTI

A process for the isolation of $^{242}Cm$ in the 100-Ci range was developed and tested. The separation apparatus for mechanical and chemical processing of a 200-mg sample of $^{241}Am$ irradiated in a high-flux reactor is remote-controlled and is continuously supervised by means of a gamma spectroscope. The Cm is separated from Am, Pu, and fission products on cation exchangers. The trivalent actinides and lanthanides are first absorbed on an exchanger column, and $^{103}Ru$ and $^{95}Zr$, $^{99}Nb$, and tetravalent $^{238,242}Pu$ are eluted as sulfato and oxalato complexes. $^{91}Y$, $^{144}Ce$, trivalent $^{238,242}Pu$, $^{241}Am$, and $^{242}Cm$ are then separated on a larger column by an automatic pH-gradient elution technique with $\alpha$-hydroxyisobutyric acid as the eluent. Author (NSA)

N69-13265# Ministry of Technology, Orpington (England).
**DINITROAMINES IN MANNICH CONDENSATION: PAPER 2: CONDENSATION OF ETHYLENEDINITROAMINE WITH PRIMARY MONOAMINES**
N. V. Mekarov et al Oct. 1968 5 p refs Transl. into ENGLISH from Izv. Akad. Nauk. SSSR, Ser. Khim (Moscow), no. 8, 1967 p 1837–1839
Avail: CFSTI

The initial basicity of the primary amine introduced into the Mannich condensation with ethylenediamine leads to formation of the cyclic compound at the greater value of pH. Irrespective of the basicity index of the initial amine, in all cases 3-alkyl-1,5-dinitro-1,3,5-triazocycloheptanes results. Author

N69-13272# Uppsala Univ. (Sweden). Inst. of Physics.
**COHESIVE ENERGY AND ELASTIC CONSTANTS OF $M_gO$ WITH PARTIALLY SCALED WAVE FUNCTIONS**
J. L. Calais, K. Maekilae, K. Mansikka, G. Pettersson, and J. Vallin Apr. 1968 13 p refs
(UUIP-584) Avail: Issuing Activity

The cohesive energy, the compressibility, and the elastic constants of MgO were calculated by an extension of Löwdin's method. The extension made the method valid for some deformation of the negative ions. Author (NSA)

N69-13297# European Atomic Energy Community, Karlsruhe (West Germany).
**COULOMETRIC DETERMINATION OF THE WATER CONTENT OF URANIUM-PLUTONIUM OXIDE AND URANIUM OXIDE [COULOMETRISCHE BESTIMMUNG DES WASSERGEHALTES VON URAN-PLUTONIUMOXID UND URANOXID]**
W. J. Bartscher Sep. 1968 16 p refs In GERMAN, ENGLISH summary
(EUR-4050-D) Avail: CFSTI

The determination of traces of water in uranium-plutonium oxide and uranium oxide is described. The sample is heated to 700° C and the water vapor is passed into a phosphor-pentoxide-containing cell with the aid of a current of nitrogen. The phosphoric acid formed is electrolyzed, and the amount of current necessary for this electrolysis is measured. From this amount the water content can be calculated. Results of this determination are given. The calibration of the apparatus and of the method is described. Author

N69-13342# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**AN EXPERIMENTAL DETERMINATION OF ELECTRICAL CONDUCTIVITY AND INTEGRAL HEMISPHERICAL AND MONOCHROMATIC ($\lambda$ = 0.65 $\mu$) EMISSIVITY OF THE CARBIDES OF NIOBIUM AND ZIRCONIUM [EKSPERIMENTAL'NOYE OPREDELENIYE ELEKTROSOPRO-PROTIVLENIYA, INTEGRAL'NOY POLUSFERICHESKOY I MONOKHROMATICHESKOY ($\lambda$ = 0,65 $\mu$) IZLUCHATEL'NOY SPOSOBNOSTI KARBIDOV NIOBIYA I TSIRKONIYA]**
V. A. Petrov et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 302–311 refs (See N69-13314 03-03)
(SM-74/230) Avail: CFSTI

The carbides of niobium and zirconium are prospective materials for electrodes of closed cycle MHD generators operating at temperatures up to 3000° C. In this connection the determination of the thermophysical and electrophysical properties of these carbides at extremely high temperatures is of great significance. The determination of the integral hemispherical emissivity in the present study is based on a calorimetric method which is described in detail. Author

N69-13344# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**A MASS-SPECTROMETRIC STUDY OF GASEOUS COMPOUNDS OF ALKALIMETALS [MASS-SPEKTROMET-RICHESKOYE ISSLEDOVANIYE GAZOOBRAZNYKH SOYE-DINENIY SHCHELOCHNYKH METALLOV]**
A. V. Gusarov et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 317–327 refs (See N69-13314 03-03)
(SM-74/233) Avail: CFSTI

Up to the present time, the gaseous oxides of lithium, LiO, $Li_2O$, and $Li_2O_2$ were studied quite thoroughly. Information on the stability of gaseous oxides and carbonates of other alkali metals is almost entirely lacking. In this connection, a mass spectrometric study of the evaporation products of the oxides and carbonates of potassium and cesium was undertaken. Author

N69-13387# Massachussetts Univ., Amherst. Polymer Research Inst.
**THE DICHROISM AND BIREFRINGENCE OF POLYMER CONTAINING CONJUGATED POLYENE SEQUENCES. 3**
Richard S. Stein and Yohji Shindo Aug. 1968 23 p refs
(Contract Nonr-3357(01))
(AD-676693; ONR-TR-100) Avail: CFSTI CSCL 7/4

In previous publications, the dichroism and birefringence of rubber-like networks composed of polymer chains containing conjugated polyene segments were discussed. The previous treatments are based to a considerable extent on the Kuhn-Grun theory of birefringence for rubber networks. In this paper, the same problem is discussed applying the treatment of polymer configuration by Hill and of bond orientation by Saito. Author (TAB)

N69-13405# Atelier de Construction, Tarbes (France). Direction Technique des Armements Terrestres
**PROBLEMS OF QUALITATIVE ANALYSIS OF PRIMER EXPLOSIVES [LES PROBLEMES D'ANALYSE DES EXPLOSIFS D'AMORCAGE]**
J. L. Cazaux 1968 6 p In FRENCH Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

The chemical methods employed for the quantitative analyses and purity evaluation of the primer mixtures used in igniting explosives are reviewed. ESRO

**N69-13415#** Kernforschungsanlage, Juelich (West Germany).
**TWO THETA VALUES FOR THE X-RAY SPECTRUM ANALYSIS WITH LITHIUM FLUORIDE, (200), 2D EQUALS 4.0276 ANGSTROM AS ANALYZER CRYSTAL [2 THETA-WERTE FUER DIE ROENTGENSPEKTRALANALYSE MIT LITHIUMFLUORID, (200), 2D GLEICHT 4,0276 ANGSTROM ALS ANALYSATORKRISTALL]**
C. Freiburg and W. Reichert Jun. 1968 61 p refs In GERMAN
(JUL-534-CA) Avail: CFSTI

For abstract, see N69-13416.

**N69-13416#** Kernforschungsanlage, Juelich (West Germany).
**TWO THETA VALUES FOR THE X-RAY SPECTRUM ANALYSIS WITH LITHIUM FLUORIDE, (220), 2D EQUALS 2,848 ANGSTROM AS ANALYZER CRYSTAL [2 THETA-WERTE FUER DIE ROENTGENSPEKTRALANALYSE MIT LITHIUMFLUORID, (220), 2D GLEICHT 2,848 ANGSTROM ALS ANALYSATORKRISTALL]**
C. Freiburg and W. Reichert Jun. 1968 52 p refs In GERMAN
(JUL-535-CA) Avail: CFSTI

Two computer-derived tables are presented, one listing the 2 $\theta$ values in order of increasing wave length, the other listing the values in rearranged order of increasing atomic number of the elements. The reflection value of the crystal is given up to the fifth order. Relative intensity values are included for quick reference, expressed on a standard of 100 of the $\alpha_1$ lines. Transl. by K.W.

**N69-13417#** Kernforschungsanlage, Juelich (West Germany).
**TWO THETA VALUES FOR THE X-RAY SPECTRUM ANALYSIS WITH TOPAZ, (303), 2D EQUALS 2,712 ANGSTROM AS ANALYZER CRYSTAL [2 THETA-WERTE FUER DIE ROENTGENSPEKTRALANALYSE MIT TOPAS,(303), 2d GLEICHT 2712 ANGSTROM ALS ANALYSATORKRISTALL]**
C. Freiburg and W. Reichert Jun. 1968 49 p In GERMAN
(JUL-536-CA) Avail: CFSTI

For abstract, see N69-13416.

**N69-13426#** Yale Univ., New Haven, Conn. Dept. of Chemistry.
**PARAMAGNETIC AND ELECTRIC QUADRUPOLE HYPERFINE INTERACTIONS OF FERRIC IONS IN ICE AND $FeCl_3 \cdot 6H_2O$**
Arthur J. Nozik and Morton Kaplan Apr. 1968 25 p refs
(YALE-3219-19) Avail: CFSTI

Mössbauer resonance in $^{57}Fe$ has been used to study the species $Fe(H_2O)_5Cl^{2+}$ and $Fe(H_2O)_6^{3+}$ in frozen aqueous solutions of ferric chloride and ferric nitrate. The spectral lines display pronounced broadening as the temperature is lowered, as a result of paramagnetic relaxation effects. In dilute samples at 4.2°K, resolved paramagnetic hyperfine structure was observed for both species and permitted identification of the lowest crystal field states of the ferric ion. The effective magnetic fields originating from the $|\pm 5/2\rangle$ Kramers doublets were determined as 553 kG in $Fe(H_2O)_5Cl^{2+}$ and 588 kG in $Fe(H_2O)_6^{3+}$. The latter ion showed no evidence of an electric quadrupole interaction, whereas the former exhibited a significant quadrupole splitting due to the coordinated Cl – ligand. Results are presented for crystalline $FeCl_3 \cdot 6H_2O$, in which the ion $Fe(H_2O)_4Cl_2^+$ exists as a structural unit. Author (NSA)

**N69-13444#** Naval Radiological Defense Lab., San Francisco, Calif.
**ISOTHERMAL PYROLYSIS OF CELLULOSE. KINETICS AND GAS CHROMATOGRAPHIC/MASS SPECTROMETRIC ANALYSIS OF THE DEGRADATION PRODUCTS**
Anne E. Lipska and Frank A. Wodley Mar. 1968 44 p refs
(AD-676351; USNRDL-TR-68-89) Avail: CFSTI CSCL 7/4

The objective of the work was to study the degradation processes of untreated and fire retardant treated cellulose above 300C. The basic overall decomposition mechanism, in terms of three phases of pyrolysis based on weight loss measurements of the untreated cellulose between 316C - 360C, is similar to that observed between 276C - 298C. This observation was supported by measurements on the rates of formation of degradation products directly generated in the time-of-flight mass spectrometer at 298C. A 2% KHCO3 treatment of the white alpha cellulose at 300C increased the rate of volatilization 7-fold. The results of a gas chromatographic-mass spectrometric analysis of the volatile degradation products of the untreated and fire retardant treated cellulose indicated that: There is little difference in either the quality or relative quantity of volatiles generated during the three different stages of pyrolysis; the fire retardant, KHCO3, does not markedly change the types of degradation products having molecular weights below about 110, although it does change their relative concentrations; the initial rapid weight loss in both cases is not due to desorption of water, but primarily to decomposition of the cellulose molecules. TAB

**N69-13451*#** Bureau of Mines, Minneapolis, Minn. Metallurgy Research Center.
**EFFECT OF PHYSICAL PARAMETERS ON THE REACTION OF GRAPHITE WITH SILICA IN VACUUM**
L. A. Hass and S. E. Khalafalla Dec. 1968 26 p refs
(NASA Order R-09-040-001)
(NASA-CR-97932; BM-RI-7207) Avail: CFSTI CSCL 07C

The degree of reduction of various silica-graphite mixtures was studied in a batch reactor to determine optimum physical conditions for maximizing the carbothermic reduction of silica. The extent of interaction was determined for reactant mixtures in loose powder and briquet forms at pressures less than 0.01 torr and temperatures up to 1,445°C. Molar ratios were varied from 0.05 to 6.5 with maximum reaction at a ratio of about 1.5. The solid-solid reaction did not appear to involve gaseous intermediates. The extent of reaction better correlated with the number of interparticle contacts than with the true surface area of the reactants. Carbonized dextrose was a better reductant than graphite. Author

**N69-13488#** Bhabha Atomic Research Center, Bombay (India). Chemistry Div.
**AN IMPROVED VOLUMETRIC METHOD FOR O/U ANALYSIS**
S. R. Dharwadkar and M. S. Chandrasekharaiah 1968 12 p refs
(BARC-341) Avail: CFSTI

A simple volumetric method for determination of O/U ratio was developed. $UO_{2+x}$ samples were dissolved in acidified solution of ceric ammonium sulphate and the amount of $Ce^{+4}$ utilized in conversion of $U^{+4}$ to $U^{+6}$ in solution was estimated by back titration with ferrous ammonium sulphate using Ferroin as an indicator. Overall acidity was adjusted to give about 3N at the end point. The precision in O/U obtained by this method is ±0.0032 and ±0.0038 near $UO_2$ and $U_3O_8$ and respectively. Author

**N69-13493#** Naval Research Lab., Washington, D. C.
**POTENTIOSTATIC CURRENT-POTENTIAL MEASUREMENTS ON IRON AND PLATINUM ELECTRODES IN HIGH-PURITY CLOSED ALKALINE SYSTEMS**

Clarence M. Shepherd and Sigmund Schuldiner 28 Aug. 1968 18 p refs
(ARPA Order 878)
(AD-676734; NRL-6748) Avail: CFSTI CSCL 7/4

Potentiostatic polarization curves were determined for Fe, Pt, and combinations of Fe and Pt electrodes in NaOH and LiOH solutions saturated with helium. With the high-purity, gastight system used, the level of reactable impurities was reduced to about 0.000001 ppm. Under these conditions the primary reactions are, depending on potential, the oxidation or reduction of OH(-) and water. Iron does not significantly corrode or show a decrease in reaction rate with an increase in potential (passivate). Iron acts like an inert noble metal similar to platinum. Chloride ion causes extensive iron corrosion, completely changes the potentiostatic polarization behavior, and does cause typical passive behavior. Under high-purity conditions, iron is an excellent catalyst for the hydrogen oxidation reaction; the presence of chloride ion, however, almost completely destroys the catalytic properties of Fe for this reaction. Unreactable and unremovable impurities such as carbonates, silicates, sulfates, apparently do not have major effects on the polarization behavior of Fe. The major anion, OH(-), appears to dominate the inert anion effects. Author (TAB)

N69-13500# Massachusetts Univ., Amherst. Polymer Research Inst.
**CALCULATION OF OSCILLATOR STRENGTH AND ESTIMATION OF THE ABSORPTION COEFFICIENTS IN CONJUGATED LINEAR POLYMER COMPOUNDS**
Yohji Shindo and Richard S. Stein Apr. 1968 35 p refs
(Contract Nonr-3357(01))
(AD-676695; ONR-TR-98) Avail: CFSTI CSCL 7/4

In order to calculate the dichroism of oriented polymer molecules containing polyene units, it is necessary to know the oscillator strength of a polyene unit as a function of its degree of conjugation. Free electron and molecular orbital calculations of such oscillator strengths are extended for this purpose. Author (TAB)

N69-13510# Atelier de Construction, Tarbes (France). Direction Technique des Armements Terrestres.
**CHEMISTRY OF EXPLOSIVE DERIVATIVES OF TETRAZOLES [CHIMIE DES DERIVES EXPLOSIFS DES TETRAZOLES]**
H. Morisson 1968 13 p refs In FRENCH Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

The fabrication, chemical properties and possible uses of aminotetrazole are described. The production of other explosive tetrazole compounds and the determination of their ignition temperatures, shock resistance, etc. are also discussed. ESRO

N69-13529# IIT Research Inst., Chicago, Ill.
**ADVANCED OXIDIZER CHEMISTRY Technical Summary Report, 1 Apr.–31 Jul. 1968**
Irvine J. Solomon 15 Aug. 1968 12 p refs
(Contract F44620-68-C-0039)
(AD-676690; IITRI-C6135-2) Avail: CFSTI CSCL 7/3

Perfluoropropene and O2F2 reacted to give two new compounds (CF3)2CFOOF and CF3CF2CF2OOF, however it was not possible to seperate these isomers from each other. In an attempt to prepare pure CF3CF2CF2OOF, perfluorocyclopropane was allowed to react with O2F2. The reaction of perfluoroethylene oxide and O2F2 was also studied. The mechanism of the reaction of COF2 and OF2 to give CF3OOOCF3 is being studied by conventional and oxygen-17 tracer techniques. Author (TAB)

N69-13545# Naval Ammunition Depot, Crane, Ind.
**A PRELIMINARY INVESTIGATION INTO THE EFFECT OF ADDITIVES ON THE PERFORMANCE OF FLARE COMPOSITIONS**
Sidney L. Howlett (Defence Standards Labs., Melbourne) 4 Sep. 1968 22 p refs
(AD-676509; RDTR-128) Avail: CFSTI CSCL 19/1

This report describes preliminary experiments in the study of the effects of additives on the performance of illuminating flare compositions. The results indicate trends in performance and provide data from which large scale experiments can be planned. A theory is proposed to explain the periodic fluctuation in light output observed in most flare systems. Author (TAB)

N69-13556# Denver Research Inst., Colo. Mechanics Div.
**RADIATION INTENSITY PRODUCED BY EXPLOSIVELY EXCITED ARGON GAS Final Report, 28 Dec. 1967–30 Aug. 1968**
Robert M. Blunt Sep. 1968 25 p refs
(Contract N00164-68-C-0229)
(AD-676510; RDTR-132; FR-4050-6807-F) Avail: CFSTI CSCL 14/5

A study was made of the time history of the luminous intensity produced by a shock wave in argon gas. The shock wave was produced by detonating a 45 gram charge of composition C-4 attached to one end of a 28 mm diameter glass tube about 1.25 meters long. The tube contained argon gas at a nominal 630 torr pressure. Several charge shapes were used; there were also two tests in which 100 grain primacord located on the axis of the glass tube replaced the charge of C-4. Best results were obtained from an unlined conical cavity charge. The peak value was 3.9 x 10 to the 7th power candela, 6100 candela seconds from a shock moving at approximately 8300 meters/second. Author (TAB)

N69-13557# California Univ., Santa Barbara. Dept. of Chemistry.
**EFFECTS OF HIGH PRESSURES ON THE PHOSPHORESCENCE OF AROMATIC HYDROCARBONS AT 77 DEG K**
Henry W. Offen and David E. Hein Sep. 1968 18 p refs
(Contract N00014-67-A-0120)
(AD-676741; TR-14) Avail: CFSTI CSCL 7/5

The phosphorescence spectra and lifetimes of naphthalene, naphthalene-dB, and 2-bromonaphthalene were studied in EPA at 77K as a function of pressure in the 0-40 kbar range. The triplet energy is lowered by approx. 1% at 30 kbar corresponding to a red shift of 7.5/cm/kbar for C10D8 and C10H8. Increasing pressures tend to blurr vibrational structure to a significant extent so that at 30 kbar only two broad bands separated by approx. 1400/cm remain for these three compounds. The triplet lifetimes at 30 kbar are shorter than at 1 atm by 10, 30, and 50% for bromonaphthalene, naphthalene, and naphthalene-dB, respectively. The pressure-induced enhanced electronic relaxation is discussed in terms of the activation volume parameter. The difference in the pressure response of the C10D8 and C10H8 triplet decay is attributed to an increase in the vibrational overlap factor of deuterated naphthalene under pressure, leading to higher radiationless transition rates in this molecule. Author (TAB)

N69-13610# Bhabha Atomic Research Centre, Bombay (India). Metallurgy Div.
**X-RAY DIFFRACTION EFFECTS ARISING FROM STACKING FAULTS IN ALPHA URANIUM**
R. Krishnan 1968 11 p refs
(BARC-343) Avail: CFSTI

Based on the accepted crystal structure of alpha Uranium as orthorhombic and the specified atomic arrangement of the (001) plane, the possible types of faults are deduced. They are: 1Δ, which is obtained by removal or insertion of a plane and which is

equivalent to condensation of vacancies or interstitials on that plane; 2Δ, two faults produced by partial slip displacements over the (001) plane, one a single fault bounded by sessile dislocations and the other a double fault bounded by glissile dislocations and associated with an extended dislocation lying in the (001) plane. X-ray reflection effects from the partial slip displacement faults (2Δ) are derived by finding the probability of fault occurrence and determining an intensity reflection broadening that is about 12 times greater for $L_0$ even than for $L_0$ odd. No peak displacement or assymmetries occur from these faults. In the 1 faults the probability of occurrence is developed and intensity reflection broadening is found to be about 2.5 times greater for $L_0$ even than for $L_0$ odd. D.H.B.

**N69-13628#** Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.
**SPECTROSCOPIC STUDY of Pb 206, 207 AND 208 ISOTOPES BY HIGH RESOLUTION ANALYSIS OF 24.5 MeV PROTON SCATTERING [ETUDE SPECTROSCOPIQUE DES ISOTOPES 206, 207 ET 208 DU PLOMB PAR ANALYSE A HAUTE RESOLUTION DE LA DIFFUSION DE PROTONS DE 24,5 MeV]**
Gerard Vallois (Ph.D. Thesis--Paris Univ., Orsay, 7 Mar. 1968) Jun. 1968 125 p refs In FRENCH; ENGLISH summary
(CEA-R-3500) Avail: CFSTI

206, 207, 208 Pb have been studied by 24.5 MeV proton inelastic scattering with a resolution of 20 keV. The angular distributions of the differential cross-sections corresponding to the different excited levels have been measured in a large angular region and analyzed with the DWBA. This work shows that it exists between 4 and 5 MeV of excitation energy some strongly excited levels corresponding to transfer momenta l=2, 4, 6 and 8. The single particle-hole models do not explain these states; so it will probably be necessary to introduce some several particle-hole configurations. Author (ESRO)

**N69-13630#** Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry.
**NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH Progress Report, 1967–1968**
Truman P. Kohman 31 Jul. 1968 83 p refs
(Contract AT(30-1)-844)
(NYO-844-75) Avail: CFSTI

Research is reported on: Cd abundances in tektites, Moessbauer spectroscopy of iron in coal, alpha spectra of U in tektites, isotopic composition of Tl in meteorites, Hg and Bi abundances in iron meteorites, gamma-gamma coincidence spectrometer, determination of Tl and Pb in meteorites, natural radioactivity of $^{48}Ca$, and counting systems. NSA

**N69-13631#** United Kingdom Atomic Energy Authority, Wantage (England). Isotope Research Div.
**THE MECHANISM OF ADSORPTION OF RARE EARTH CATIONS ON TO SURFACES FROM VERY DILUTE SOLUTION ("RADIOCOLLOIDAL" ADSORPTION)**
C. E. Mellish, M. R. H. Hill, and D. E. Glanville Dec. 1968 13 p refs
(AERE-R-5323) Avail: CFSTI

Previous qualitative work on cation adsorption was followed by quantitative measurements on the adsorption of rare earth ions on electrochemically oxidized platinum, stearic acid monolayers, and tungsten metal. On all these the same type of process appears to take place; adsorption is dependent on pH and on oxide coverage (on Pt) but independent of cation concentration even at carrier-free levels. The results indicate that ions are held to the surface by hydrogen bonds or covalent bonds in addition to simple ionic attraction. The interaction may be used as an investigational tool for the study of surface oxides, as with the experiments on platinum, for the measurement of diffusion coefficients, as with the experiments with stearic acid monolayers, and for substoichiometric dilution analysis, using tungsten surfaces. Author (NSA)

**N69-13657#** Monsanto Research Corp., Dayton, Ohio.
**BASIC RESEARCH ON SYNTHESIS OF NEW PHOSPHORUS-NITROGEN REAGENTS Final Scientific Report, 1 Dec. 1965–1 Dec. 1967**
George A. Richardson and Morris L. Nielsen Wright-Patterson AFB, Ohio ARL May 1968 42 p refs
(Contract AF 33(615)-2218)
(AD-676650; ARL-68-0101) Avail: CFSTI CSCL 7/2

Judiciously selected derivatives and metal chelates of two classes of phosphorus-nitrogen reagents were prepared and characterized by their physical properties. The compounds are as follows: (I) (RO)2PNHP(OR)2; (Ia) R = CH3-; (Ib) R = C2H5-; (Ic) R = CF3CH3-; (C2H5)2PNHP(C2H5)2. The zinc salt of Ib and the zinc, copper, and possibly the iron salts of II have been synthesized. Attempts to synthesize Ia were unsuccessful; the only products isolated were the trialkyl and dialkyl derivatives. Compound Ic was isolated in low yield; the intermediate, (RO)2PN = P(OR)3, was unusually stable. The metal chelates of Ia and Ib were readily hydrolyzed to lower alkyl derivatives by atmospheric moisture. Compound II was extremely hygroscopic and formed a mono- or sesquihydrate depending upon the environmental humidity. The acidity of compound II is notably lower than that of Ib. Author (TAB)

**N69-13683#** Idaho Univ., Moscow. Dept. of Chemistry.
**NEW HYPOFLUORITES CONTAINING NITROGEN Annual Report, 1 Oct. 1967–30 Sep. 1968**
Jeanne M. Shreeve 1 Oct. 1968 53 p refs
(Contract Nonr-4217(00))
(AD-676878; AR-5) Avail: CFSTI CSCL 2/2

Contents: Difluoroamino compounds; Reactions of N,N-bis(trifluoromethyl) hydroxylamine with sulfur and nitrogen halides; Some perfluoroalkyl sulfinyl halides (New preparations of trifluoromethyl sulfur trifluoride); Reactions of halodifluorophosphines with silver salts. TAB

**N69-13686#** California Univ., Los Angeles. Dept. of Engineering.
**THE ELECTROCHEMICAL REDUCTION OF META-DINITROBENZENE IN DIMETHYLSULFOXIDE**
John S. Dunning and Douglas N. Bennion (M.S. Thesis) Jul. 1968 74 p refs
(Contract N123(62738)57439A)
(AD-676318; REPT-68-40) Avail: CFSTI CSCL 7/4

The electrochemical reduction of meta-dinitrobenzene in solutions of dimethylsulfoxide was studied on platinum electrodes. The object of the investigation was to determine the number of electrons transferred and the mechanism of transfer in the presence and absence of a proton donor, ammonium perchlorate. The electrochemical reduction in the absence of a proton donor takes place in two steps, which correspond to the formation and reduction of the m-DNB radical anion. When a proton donor is added, a homogeneous reaction takes place in the solution near the electrode which results in an effective increase in the number of electrons to four, corresponding to the reduction to nitrophenyl hydroxylamine. In separate studies, the diffusion coefficient of m-DNB in DMSO is found by the diaphragm cell method to be 0.00000615 sq cm/sec. The solubility is found to increase from 3.51 molal at 24C to 4.84 molal at 49.75C. Author (TAB)

**N69-13801#** California Univ., Los Angeles. Dept. of Engineering.
**CONDUCTANCE AND ELECTROCHEMICAL BEHAVIOR OF m-DINITROBENZENE IN LIQUID AMMONIA SOLUTIONS**

William H. Tiedemann (M.S. Thesis) Jul. 1968 68 p refs
(Contract N123(62738)57439A)
(AD-676319; REPT-68-41) Avail: CFSTI CSCL 7/4

Two studies of m-DNB in liquid ammonia solution are reported. The first study was concerned with the conductance behavior of m-DNB in liquid ammonia over a range of temperatures and concentrations. The second study deals with the determination of the overall number of electrons transferred in the reduction of m-DNB in NH4NO3-NH3 solutions. Included as part of this study was the determination of the diffusion coefficient of m-DNB in NH4NO3-NH3 solutions. Two independent electrochemical techniques were employed to obtain the overall number of electrons.
Author (TAB)

**N69-13699#** Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy and Materials Science.
**ENTHALPY INTERACTION COEFFICIENTS OF SILVER, CADMIUM AND GOLD IN DILUTE QUATERNARY TIN-RICH SOLUTIONS**
A. K. Jena and M. B. Bever 10 Oct. 1968 17 p refs
(Contract Nonr-3963-(19))
(AD-676897; TR-8) Avail: CFSTI CSCL 20/11

Equations for the heat effects of additions of mixtures of multicomponent phases to a solution have been derived in terms of the enthalpy interaction coefficients. By these equations and the measured composition dependence of the heat effects on addition of mixtures of silver-cadmium solid solutions and elemental gold to liquid tin-rich solutions, values of the enthalpy interaction coefficients in tin-rich solutions at 541 degrees K have been obtained. Analysis of these results in terms of the regular solution theory and the quasichemical theory suggests that near the melting point of the solvent association in the solution becomes important.
Author (TAB)

**N69-13752#** Monsanto Research Corp., Dayton, Ohio.
**INFRARED AND FAR INFRARED INTENSITY STUDIES Final Report, Jul. 1967–Mar. 1968**
W. J. Orville-Thomas (Salford Univ., Engl.) Wright-Patterson AFB, Ohio AFSC, Mater. Lab. Sep. 1968 87 p refs Prepared in cooperation with Salford Univ., Engl.
(Contract F33615-67-C-1363)
(AD-676270; AFML-TR-68-150) Avail: CFSTI CSCL 20/6

The object of this work is to measure the absolute intensities of infrared bands associated with the presence of important chemical groups; to collate these data with published work, and to produce frequency - intensity - structure correlations.
Author (TAB)

**N69-13755#** Ministry of Technology, Orpington (England).
**DINITROAMINES IN MANNICH CONDENSATION: PAPER 1: CONDENSATION OF ETHYLENEDINITROAMINE WITH ALIPHATIC DIAMINES**
S. S. Novikov et al Oct. 1968 6 p refs Transl. into ENGLISH from Izv. Akad. Nauk. SSSR, Ser. Khim. (Moscow), no. 8, 1967 p 1833–1837
(MINTECH/T-5785) Avail: CFSTI

Several bicyclic Mannich bases, derived from ethylenedinitroamines, formaldehyde, and some primary amines of varying basicity are obtained and described. The relation of pH level of reaction and the degree of basicity of the diamine is examined. The basicity of the diamines does not affect the course of the reaction of ethylenedinitroamine, formaldehyde, and diamine.
Author

**N69-13756#** Commissariat à l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires.
**THE KINETICS OF OXIDATION OF URANIUM MONOCARBIDE IN DRY OR MOIST OXYGEN [CINETIQUE D'OXYDATION DU MONOCARBURE D'URANIUM PAR L'OXYGENE SEC OU HUMIDE]**
Brigitte Herrmann and Franz-Josef Herrmann Jun. 1968 21 p refs In FRENCH; ENGLISH summary Sponsored in part by EURATOM
(CEA-R-3496) Avail: CFSTI

The kinetics of oxidation of uranium monocarbide either in dry or moist air or in oxygen-argon mixtures, has been studied thermogravimetrically, between 500 and 800°C in a circulating atmosphere. In all cases the oxidation leads to the formation of $U_3O_8$. Between 500 and 700°C, the activation energy is about 21 ±3 kcal/mole. It seems to decrease between 700 and 800°C, but the reaction follows always a linear ratelaw. In moist air, the oxidation proceeds more swiftly, due to an increase in the reactional interface. An evaluation of the overtemperature has been made at 800°C.
Author (ESRO)

**N69-13765#** Puerto Rico Nuclear Center, Mayaguez.
**NEUTRON DIFFRACTION PROGRAM Progress Summary Report**
M. I. Kay, S. F. Kaplan, R. Kleinberg, J. A. Gonzalo, and D. T. Cromer Apr. 1968 36 p refs
(Contract AT(40-1)-1833)
(PRNC-115; PSR-6) Avail: CFSTI

The neutron diffraction group worked on essentially two types of problems. The first was concerned with the chemical binding of atoms in crystals and molecules, and the second with the nature of ferromagnetism. Both problems are related to the spatial arrangement of atoms in molecules. Spiral oscillations of the sulfate group in sodium alum ($NaAl(SO_4)_2 \cdot 12\ H_2O$) were studied. The ferroelectrics sodium nitrite and sodium trihydrogen selenite were also studied.
NSA

**N69-13776#** Dow Chemical Co., Golden, Colo. Rocky Flats Div.
**IMPURITY REMOVAL BY FLUORINATION OF PLUTONIUM DIOXIDE BETWEEN 28°C AND 300°C**
James D. Navratil and Ralph O. Wing 5 Sep. 1968 8 p refs
(Contract AT(29-1)-1106)
(RFP-1052) Avail: CFSTI

Fluorination of plutonium dioxide between 28 and 300°C was investigated in a static-bed fluoride volatility system at Rocky Flats. Boron, chromium, molybdenum, silicon, tantalum, and titanium impurities were significantly removed from the plutonium dioxide after fluorinating at 300°C for 15 minutes. Less than 1% of the plutonium was volatilized during these fluorinations, and approximately 99% of the plutonium dioxide was converted to plutonium tetrafluoride. All effective impurity removal, for the system investigated, was accomplished in the initial 15 minutes of reaction. Conversion of plutonium dioxide to plutonium tetrafluoride was essentially complete within the same period of time.
Author (NSA)

**N69-13783#** Oak Ridge National Lab., Tenn.
**VAPOR PRESSURE OR TELLURIUM DIOXIDE**
A. P. Malinauskas Sep. 1968 19 p refs
(Contract W-7405-ENG-26)
(ORNL-4300) Avail: CFSTI

Results of a survey of the literature on the determination of the vapor pressure of tellurium dioxide are presented. Data are reported as derived from the mass transport method and the Knudsen effusion technique, and an attempt is made to utilize the results of the two methods to assess the extent of dimer formation in the gas phase. Until a more definitive assessment of polymer formation can be made, it is proposed that the expression $\log_{10} p(\text{torr}) = 12.3487 - (13.238 \pm 10^3)/T$ be employed for the calculation of vapor pressure of $TeO_2$ over the solid in the temperature range 700°K<T<1000°K. From this expression the heat of sublimation is calculated to be 60.58±0.33 kcal/mole.
Author (NSA)

**N69-13787#** Joint Inst. for Nuclear Research, Dubna. (USSR). Lab. of Nuclear Problems.

**EFFECTS OF RADIATION ON THE SEPARATION OF BINARY LIQUID SOLUTIONS**

L. K. Lytkin, A. F. Pisarev, A. P. Sumbaev, and S. F. Chalkin 1968 9 p refs In RUSSIAN

(JINR-P13-3943) Avail: CFSTI

The effects of $\gamma$ radiation on the separation rate of nitrobenzene solution in hexane at a mole concentration of 0.2 and 0.3 and aqueous triethylamine at a concentration of 0.4, which are supersaturated, was studied. The supersaturation was attained by the impulse changing the pressure over the solution, by fast heating, and by applying an electric field. It was determined that $\gamma$ radiation speeds up the process of solution separation.

Author (NSA)

**N69-13797#** Commissariat à l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucléaires.

**KINETIC STUDY OF THE REACTION OF NITROGEN WITH URANIUM MONOCARBIDE [ETUDE CINETIQUE DE LA REACTION DE L'AZOTE SUR LE MONOCARBURE D'URANIUM]**

Franz-Josef Herrmann (Ph.D. Thesis–Sarrebruck Univ., Dec. 1966) Apr. 1968 49 p refs In FRENCH; ENGLISH summary

(CEA-R-3398) Avail: CFSTI

The nitration of uranium monocarbide pieces, microspheres and powder as well, is investigated in the temperature range 700–1200°C and the kinetics of this reaction specified, using a thermogravimetric experimental procedure. In every case the kinetics appear to be linear, except for massive monocarbide at temperatures above 950°C which obeys the rate law: $\Delta m^x = Kt$, with $x = 1.5 \pm 0.1$. Accordingly, the activation energy varies from 15 to 30 Kcal/mole. Furthermore, as shown by the curves $K = F(P)$, the rate of nitration increases proportionally to the square root of nitrogen pressure. The study of the overtemperature of the powders can explain their particular behavior. A reactional mechanism is suggested based on all experimental results.

Author (ESRO)

**N69-13810#** Northwestern Technological Inst., Evanston, Ill.

**INTERVAL PROGRAMMING: A NEW APPROACH TO LINEAR PROGRAMMING WITH APPLICATIONS TO CHEMICAL ENGINEERING PROBLEMS**

Phillip D. Robers and Adi Ben-Israel Sep. 1968 22 p refs

(Contracts Nonr-1228(10); DA-31-124-ARO(D)-322; Grant NSF GP-7550)

(AD-676519; SRM-220) Avail: CFSTI CSCL 12/2

Chemical engineering problems of blending, mixing, furnace loading, etc., frequently have the form maximize $c(t)x$ subject to $b(-) < or = A x < or = b(+)$ where the matrix A, vectors b(-), b(+), c are given. We denote by interval programming, abbreviated IP, the theory, computations and applications of problems of this form. The purpose of this paper is to present a finite iterative method for solving IP called SUBOPT (abbreviation of suboptimization method) and to demonstrate its effectiveness on a cupola charging problem, a representative of interval programming problems in chemical engineering.

Author (TAB)

**N69-13815#** Bhabha Atomic Research Centre, Bombay (India). Chemistry Div.

**HOT ATOM CHEMISTRY: ANNEALING OF RECOIL DAMAGE AND SOLID STATE ISOTOPIC EXCHANGE IN COBALT COMPLEXES**

Jagdish Shankar 1968 20 p refs

(BARC-348) Avail: CFSTI

An overview is presented on the detailed experimental work which was conducted on tris-acetylacetone Co(3) and tris-dipyridyl Co(3) perchlorate. A comparison is drawn between thermal annealing of recoil damage and solid state exchange in cobalt complexes. Based on the results, it appears that the mechanisms observed both in thermal annealing of recoil damage and in solid state isotopic exchange are similar. The electron traps are classified into three categories: (1) those formed in the recoil track, (2) those formed as a result of the interaction of the electromagnetic radiation with the solid, and (3) crystal imperfections existing before irradiation. It also appears that the recoil cobalt is present either as Co++ or as a very labile complex which gives Co++ on dissolution. It is considered likely that the recoil species exists as Co++ rather than as any complex.

M.G.J.

**N69-13831#** Oak Ridge National Lab., Tenn.

**ELECTRONIC PROPERTIES OF LIQUID WATER IN THE VACUUM REGION**

Linda R. Painter (M.S. Thesis—Tenn. Univ.), R. D. Birkhoff (M.S. Thesis—Tenn. Univ.), and E. T. Arakawa (M.S. Thesis—Tenn. Univ.) Sep. 1968 113 p refs

(Contract W-7405-ENG-26)

(ORNL-TM-2261) Avail: CFSTI

In this study, n and k, the real and imaginary parts of the complex index of refraction, have been determined for water in the spectral region 1050 to 3000 Å. In order to determine the optical properties of water in the vacuum ultraviolet, two general methods were used. In the first the reflectance of water in equilibrium with its vapor at 1°C was measured in the spectral region 1050 to 3000 Å for three angles of incidence. Light from a Seya–Namioka monochromator was reflected from a gold mirror onto either the water surface or a gold reference surface at the various angles and reflected specularly onto a coronene-coated photomultiplier. The optical constants were then obtained from a solution of Fresnel's equations. This method gave reliable values of n, but the reflectances measured in this way were not accurate enough to give good values of k. The second method involved placing water against the plane surface of a transparent semicylinder which formed one side of a sealed cell.

Author (NSA)

**N69-13832#** California Univ., La Jolla. Dept. of Chemistry.

**RADICAL CARBONIUM IONS. CARBONIUM ION RADICALS AND OXY RADICALS Final Report**

Teddy G. Traylor Oct. 1968 26 p refs

(Grants AF-AFOSR-514-64; AF-AFOSR-514-66)

(AD-676663; AFOSR-68-2089) Avail: CFSTI CSCL 7/3

It was originally proposed to study the possible occurrence of radical cations in reactions in solution and to investigate the mechanisms of reactions involving metallocenes. Later the project was expanded to include studies of the behavior of oxy radicals. The object of this latter project was to determine the details of reactions of organic compounds with triplet oxygen. Some progress has been made in all these areas. Greater emphasis was placed on metallocene reactions and on oxy radical behavior. In addition to the progress on the projects themselves, some useful techniques for kinetic measurement were developed.

Author (TAB)

**N69-13886#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Materials Lab.

**VAPORIZATION KINETICS OF ALUMINUM NITRIDE. ANALYSIS OF RESULTS OF KNUDSEN CELL NITROGEN EXCHANGE REACTION Technical Report, Feb. 1968–Aug. 1967**

Emile Rutner and Edmund J. Rolinski Aug. 1968 58 p refs

(AD-676296; AFML-TR-68-120) Avail: CFSTI CSCL 7/4

A model for the exchange of nitrogen isotopes taking place between two pellets of aluminum nitride in a Knudsen cell by means of gas-solid reactions has been proposed, and the differential equations describing the kinetics of exchange in terms of vaporization, condensation, and flow rates has been solved. The equation was fitted to data of Hoch and Ramakrishnan (Reference 3). Values of vaporization and condensation and reaction rate

constants have been determined. It was also determined that the best fit to the data requires that reaction zone be defined to be equal to the thickness of 100,000 layers of atoms. The vaporization coefficients and condensation coefficient were found to be equal to each other with a value of 0.0027. This value compares closely with other values in the literature. Author (TAB)

N69-13888# Atelier de Construction de Tarbes (France). Chemical Lab.
**NEW PRIMING EXPLOSIVES AND THEIR USE IN SPACE [LES EXPLOSIFS D'AMORCAGE NOUVEAUX ET LEURS APPLICATIONS SPATIALES]**
T. Piechowicz [1968] 8 p refs In FRENCH Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

The use of explosive materials in space designs requires the study of new types and techniques. The properties of several priming explosives are discussed. ESRO

N69-13894# Rochester Univ., N. Y.
**ENDOR OF THE $O_2^-$ NEGATIVE ION IN POTASSIUM HALIDES**
A. M. Doyle and T. G. Castner Jun. 1968 6 p refs Presented at Intern. Symp. on Color Centers in Alkali Halides, Rome
(Contract AT(30-1)-3388)
(UR-3388-10; CONF-680902-4) Avail: CFSTI

The ENDOR transitions of the neighboring nuclei in KCl, KBr, and KI were measured in an effort to ascertain the local distortion employing the electric field gradients obtained from the quadrupole tensors of the neighboring nuclei. The ENDOR transitions of K and halogen nuclei neighboring the $O_2^-$ ion were observed at 9.5 GHz at temperatures below 2.3°K. Rotation spectra were obtained and interpreted for the four nearest neighbor K's and also partly for the two K nuclei directly above and below the $O_2^-$ ion. Many other K and halogen transitions were observed but not yet identified. NSA

N69-13895# Naval Ordnance Lab., White Oak, Md.
**DISPROPORTIONATION OF DIPHENYLSILANE Final Report, Jun. 1967–Jun. 1968**
J. V. Duffy and D. R. Morris Sep. 1968 16 p refs
(AD-676316; NOLTR-68-131) Avail: CFSTI CSCL 7/3

The disproportionation of diphenylsilane was determined as a function of temperature and catalyst. It was found that below 100C the stability is quite good, while at 200C, a 40% disproportionation of the starting material occurs after only two hours. The rate of rearrangement was greatly accelerated by the presence of catalysts like chloroplatinic acid. Triphenylsilane was more stable than diphenylsilane under identical conditions of temperature and catalyst. Author (TAB)

# 07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N69-12736 Cornell Univ., Ithaca, N. Y.
**OPTIMUM SIGNALS FOR HIGH RESOLUTION RADAR AND COMMUNICATIONS SYSTEMS**
Stephen Marc Gilbert (Ph.D. Thesis) 1967 150 p
Avail: Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 68-877

This investigation deals with the problem of signal design to improve radar and communication systems resolution capability. The problem is approached from two directions. First, the optimum signal amplitude in frequency is specified to produce sharply peaked autocorrelation functions. To this end, the spectral density of the deterministic signal is shown to satisfy a homogeneous Wiener—Hopf equation. A compact solution to this equation is then presented. Second, the optimum signal amplitude is combined with a nonlinear phase function to provide cross correlations with desirable properties. Since the cross correlation corresponds to an error output, a uniformly low waveform should be produced. Using the method of stationary phase integration, a detailed method for producing any desired cross correlation amplitude is presented. In particular, the techniques necessary to produce sinusoidally modulated cross correlation functions is discussed. Dissert. Abstr.

N69-12792 Virginia Univ., Charlottesville.
**HIGH MODULATION INDEX FM SPECTRA: WOODWARD'S THEOREM**
George Albert Mc Alpine (Ph.D. Thesis) 1967 114 p
Avail: Univ. Microfilms: HC $5.60/Microfilm $3.00 Order No. 67-17657

A generalized approach to the spectrum analysis of randomly frequency modulated signals is presented and indicates the need for approximate methods and knowledge of their expected accuracy. Sufficient conditions are established for the applicability of Woodward's (adiabatic) Theorem for large modulation index fm spectra and an upper bound is given for the spectral error committed in using the approximation for sinusoid and/or Gaussian random modulation. The approximate spectra are compared with computed spectra for ideal low pass, ideal band pass and sinusoidal plus ideal band pass Gaussian modulation. This comparison supports the theory developed. Dissert. Abstr.

N69-12810 California Inst. of Tech., Pasadena.
**OPTIMUM LINEAR CODING FOR ADDITIVE NOISE SYSTEMS USING INFORMATION FEEDBACK**
Stanley Butman (Ph.D. Thesis) 1967 104 p
Avail: Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 68-1670

The feedback coding problem for Gaussian systems in which the noise is neither white nor statistically independent between channels is formulated in terms of arbitrary linear codes at the transmitter and at the receiver. This new formulation is used to determine a number of feedback communication systems. In particular, the optimum linear code that satisfies an average power constraint on the transmitted signals is derived for a system with noiseless feedback and forward noise of arbitrary covariance. The noisy feedback problem is considered and signal sets for the forward and feedback channels are obtained with an average power constraint on each. The general formulation and results are valid for non-Gaussian systems in which the second order statistics are known, the results being applicable to the determination of error bounds via the Chebychev inequality. Dissert. Abstr.

N69-12841 Illinois Univ., Urbana.
**ANALYSIS OF A LOG-PERIODIC CAVITY-SLOT ANTENNA USING THREE-PORT NETWORKS**
Vitas Anthony Mikenas (Ph.D. Thesis) 1967 155 p
Avail: Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 68-1808

A general method of analyzing a certain class of antennas is described. The method applies to antennas that are composed of distinct cells identical to each other except, perhaps, for a

scaling factor. The technique described reduces the antenna problem to a circuits problem by representing each cell of the antenna by an equivalent three port network. With this approach, it is necessary to obtain the scattering coefficients characterizing each cell and the mutual coupling coefficients between the radiating cells. The method has been applied to a log-periodic structure with cells consisting of cavity backed slots excited by a series loop feed. An experimental technique for the determination of the scattering coefficients is described. An approximate formula for the complex coupling between two waveguide fed slots is derived. Computer results of several loop excitation systems indicated that they were not suitable for use in a log-periodic antenna. Dissert. Abstr.

**N69-13070*** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**STATISTICAL COMMUNICATION THEORY**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 135–146 refs
(See N69-13060 03-34)
(Grant NsG-496; Contract DA-28-043-AMC-02536(E))
Avail: CFSTI CSCL 17B

The mathematical properties of the cepstrum (Fourier transform of the logarithm of the amplitude spectrum of a signal) are considered in detail. The use of the cepstrum in a model accounting for pitch perception is speculated. It was concluded that the cepstrum is an expression that, similar to the autocorrelation function, reveals some of the main temporal features of a periodic signal, and has the original property of being almost insensitive to a wide class of transformations of the short-time energy spectrum of the signal, $\Phi(t, \omega)$. B.P.

**N69-13155*#** National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
**OPTIMUM DESIGN OF COMMUNICATION LINKS WITH NOISY PHASE REFERENCE**
William E. Zrubek Washington Dec. 1968 25 p refs
(NASA-TN-D-4895) Avail: CFSTI CSCL 17B

A binary communication link is analyzed, and an expression is obtained for bit error probability when the phase reference is noisy. Graphical results are presented which allow selection of modulation index to minimize the error probability. Author

**N69-13158*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**RADIOFREQUENCY TRANSMISSION CHARACTERISTICS OF CANDIDATE ABLATION MATERIALS FOR PLANETARY-ENTRY-VEHICLE HEAT SHIELDS**
Melvin C. Gilreath, Andreq J. Chapman, and Douglas M. Hatcher Washington Dec. 1968 62 p refs
(NASA-TN-D-4920) Avail: CFSTI CSCL 22B

An experimental investigation was conducted to determine the radiofrequency properties of several candidate ablation materials for planetary-entry-vehicle heat shields. The radiofrequency transmissibility of each ablative material was determined by the real-time measurement of the attenuation of a 35 GHz signal while each sample was exposed to a simulated planetary entry environment. The simulated planetary environment was produced by providing a heating rate, pressure, and free-stream Mach number in an arc-heated supersonic wind tunnel. Recordings of the transmission loss obtained through each material during the arc-tunnel test and photographs of all test specimens before and after thermal exposure are presented. In addition to the transmission loss measurements, the dielectric properties of most virgin materials were measured at room temperature and are also presented. Author

**N69-13216*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**EFFECT OF INTERFERENCE ON A BINARY COMMUNICATION CHANNEL USING KNOWN SIGNALS**
M. A. Koerner 1 Dec. 1968 28 p refs
(Contract NAS7-100)
(NASA-CR-97895; JPL-TR-32-1281) Avail: CFSTI CSCL 17B

An analysis is reported of the effects of sinusoidal and Gaussian interference on the performance of the maximum-likelihood receiver for extracting binary data from a sequence of messages in white Guassian noise when each signal has duration T and is chosen with equal a priori probability from a dictionary of two messages. Equations are presented for the receiver error probability and the receiver degradation as a function of the parameters $\lambda$ and $\eta$ or $\Xi$. Graphs are included which show the behavior of the receiver error probability and the receiver degradation as a function of 10 log $\lambda$ and 10 log $\eta$ or 10 log $\Xi$. Equations are presented which relate the parameters $\lambda$, $\eta$, and $\Xi$ to the basic parameters of the signal, interference, and noise. Finally, a comparison is made of the effect of a sinusoidal interfering signal with that of a Gaussian interfering signal. The comparison shows that for small values of $\lambda$ and $\eta$ or $\Xi$, the degradation produced by sinusoidal interference is close to that produced by Gaussian interference. However, the approximation is not valid for large $\lambda$ or large $\eta$ or $\Xi$. Author

**N69-13245*#** Massachusetts Inst. of Tech., Cambridge. Electronics Research Lab.
**[RESEARCH ON TECHNIQUES OF COMMUNICATION IN THE SPACE ENVIRONMENT] Semiannual Status Report, 1 May–31 Oct. 1968**
Robert G. Gallager 19 Nov. 1968 7 p refs
(Grant NGL-22-009-013)
(NASA-CR-98518) Avail: CFSTI CSCL 17B

Research is summarized which is aimed toward understanding of communication channels and sources for the development of reliable, efficient communication techniques. Progress is reported in two studies, the first of which is in optical communication and deals with the fundamental limitations and efficient utilization of optical channels, including the turbulent atmospheric channel, the cloud transmission channel, quantum-limited channels, and scatter channels. The studies range from channel modeling through feasible near-optimum communication systems to fundamental coding theorems. The second study is concerned with coding for noisy channels and for sources. Briefly described is work on systematic convolutional codes, their sequential decoding, and the transmission of a discrete-time Gaussian source over an additive white Gaussian noise channel with a mean square error criterion. K.W.

**N69-13301*#** National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
**LUNAR SURFACE TRANSMISSION LOSS FOR THE APOLLO ASTRONAUT**
Jefferson F. Lindsey, III Washington Dec. 1968 28 p refs
(NASA-TN-D-4915) Avail: CFSTI CSCL 17B

Radio-wave propagation theory is reviewed with emphasis on point-to-point communications on the lunar surface. The geometric optics solutions for both a plane surface and a spherical surface are presented. The transmission loss is found to slope at 40 dB/decade of distance at the longer distances for which the path difference between the direct and the reflected wave is less than one-half wavelength. The Bremmer series for radio-wave diffraction solution is presented for calculation of the transmission loss near the line of sight when the geometric optics solution does not apply. In addition to smooth-surface effects, the roughness effects of knife-edge diffraction and of small hills are used to obtain a combined-effects transmission loss plot. Finally, measured data are presented which confirm that the maximum astronaut-to-lunar-module range will be at least 8200 feet and that the maximum astronaut-to-astronaut range will be at least 6000 feet. Author

N69-13308*# New Mexico State Univ., Las Cruces. Dept. of Electrical Engineering.
**A STUDY OF THE IMMUNITY OF FM DISCRIMINATORS TO 2 $\pi$ FREQUENCY IMPULSES**
Frank F. Carden, George L. Davis, Lawrence R. Kelly, and William P. Osborne [1968] 4 p refs
(Grant NGR-32-003-037)
(NASA-CR-97946) Avail: CFSTI CSCL 17B

This paper reports the results of an investigation of the frequency impulse response of several FM discriminators. Experimental data are presented which display an impulse immunity of the phase-lock loop, as a result of rejection of a class of fast impulses. The results of a computer study for the phase-lock loop verify this. Experimental results for the pulse-averaging discriminator are also presented. Author

N69-13393# European Space Operations Centre, Darmstadt (West Germany). Control Centre Dept.
**ESOC/ESTRACK OPERATIONS PLAN FOR ELDO 1**
M. J. Barrett, ed. Paris ESRO Oct. 1968 26 p
Avail: CFSTI

Describes operational planning for the use of ESRO tracking networks and data processing facilities during the launching of Europa 1, ELDO F7 launch vehicle, scheduled for November 1968 from the Woomera launching site, Australia. ESRO

N69-13453*# New Mexico State Univ., Las Cruces. Electrical Engineering Dept.
**THE NON-LINEAR TRANSIENT BEHAVIOR OF SECOND, THIRD AND FOURTH ORDER PHASE-LOCKED LOOPS**
Frank F. Carden, M. Don Merrill, Carl R. Martin, and Thomas J. Jones [1968] 5 p refs
(Grant NGR-32-003-037)
(NASA-CR-97938) Avail: CFSTI CSCL 17B

The non-linear transient behavior of second, third and fourth order phase-locked loops is obtained from the projections of the respective state spaces onto the various hyper-planes. For various driving functions, regions of the parameter space are specified such that the transients may be determined by the linear model. Author

N69-13528# Communications and Systems, Inc., Paramus, N. J.
**LINEAR PROGRAMMING FOR COMMUNICATIONS NETWORKS PROGRAM REPORT**
Jun. 1968 94 p
(Contract DCA-100-67-C-0016)
(AD-676320; C/S-68-TR-2746) Avail: CFSTI CSCL 17/2

This program report provides information to programmers who may wish to change or modify the AUTOLP system prepared under Task 23, Linear Programming for Communications Networks, for the 1967 DCA System Analysis Program. This report is provided in addition to the final technical report, which gives a general overview of the task as well as descriptions of the linear programming models that characterize communication network problems, and the users manual, which describes how to use the program. Author (TAB)

N69-13532*# Ohio State Univ., Columbus. ElectroScience Lab.
**MILLIMETER-WAVELENGTHS PROPAGATION STUDIES Annual Status Report, Sep. 1, 1967--Aug. 31, 1968**
Peter Bohley and Robert L. Riegler 1 Nov. 1968 30 p refs
(Grant NGR-36-008-060)
(NASA-CR-97926; ASR-2374-2) Avail: CFSTI CSCL 17B

Preparations for Ohio State University participation in the NASA ATS-E millimeter wave experiment are described. Two terminals are under construction and will be used for space diversity experiments. The results of a study to determine some of the effects of the atmosphere on earth/space communications links are presented. Author

N69-13536*# New Mexico State Univ., Las Cruces. Communication Research Group.
**THE FDM DEMODULATING CHARACTERISTICS OF NON-LINEAR PHASE-LOCKED LOOPS**
Frank F. Carden, Lawrence R. Kelly, and Thomas B. Hintz [1968] 5 p refs
(Grant NGR-32-003-037)
(NASA-CR-97909) Avail: CFSTI CSCL 17B

The projections of the state space onto the various hyperplanes are used to determine the minimum noise bandwidth and maximum information bandwidth for non-linear phase locked loops used to demodulate FM multiplexed subcarriers. Author

N69-13811# Army Electronics Labs., Fort Monmouth, N. J.
**BORON-NITRIDE HIGH-POWER DUPLEXING DEVICE**
Edward E. Decamp, Jr., Robert M. True, and Edward V. Edwards Aug. 1968 20 p refs
(AD-676817; ECOM-3009) Avail: CFSTI CSCL 17/9

The results of an experimental program to improve the power-handling capacity of duplexer devices through the use of an improved dielectric material are described. A dielectric container made of chemical-vapor-deposited (CVD) isotropic boron-nitride (BN) is substituted for the commonly used quartz envelope. A cylindrical pre-TR that failed because of high-temperature effects at a power level of 38 MW peak, 38 kW average, using a quartz envelope, operated satisfactorily at a power level of 65 MW peak, 65 kW average, with an isotropic CVD BN cylinder. The improvements in performance that can be achieved through the use of this material are significant in high-power duplexer applications. Author (TAB)

N69-13853# Texas Univ., Austin. Electronics Research Center.
**ON OPTIMUM SPACE DIVERSITY RECEPTION OF CORRELATED MULTIPATH**
Jim H. Derryberry and William D. Gregg Jun. 1968 112 p refs
(Grant AF-AFOSR-67-0766A)
(AD-676276; AFOSR-68-1657; TR-50) Avail: CFSTI CSCL 9/4

The research effort investigates system requirements, configurations, and associated performance characteristics of maximum-likelihood space-diversity receiving systems. From the maximum-likelihood principle, and the multidimensional Karhunen-Loeve expansion, the continuous decision equations for space-time detection of noisy, random multipath signals are developed. Interpretation of these equations yields the optimum space-time receiving system configuration requirements. Author (TAB)

N69-13881# South Carolina Univ., Columbia. Dept. of Electrical Engineering.
**NON-WAVEGUIDE METHODS OF MILLIMETER WAVE TRANSMISSION Final Scientific Report**
Rufus G. Fellers and James E. Sees Jun. 1968 23 p refs
(Grant AF-AROSR-3-65)
(AD-676971; AFOSR-68-1348) Avail: CFSTI CSCL 17/2.1

The feasibility of transmission between two closely spaced antennae was established with transmission loss lower than that of rectangular waveguide. Defocus of antenna feeds has improved performance. Transmission around corners at no loss was demonstrated. The use of a dielectric sheet as a power divider was proved effective. A circular polarization duplexer was developed. A pair of dielectric prisms was used very effectively as an adjustable bi-directional coupler, as an attenuator and as a duplexer. The effect of reflections at prism surfaces was analyzed and an effective means of controlling them was devised. The effect of surface

distortions on antenna performance was analyzed and a computer program was written to compute far zone field under these conditions. Application was made to an idealized symmetrical case. A high precision antenna pattern range was set up to evaluate experimentally the patterns from distorted antennae. Only preliminary measurements were made. Author (TAB)

N69-13748# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**A COMPARISON OF ARBITRARY ADDITIVE NOISES AS REGARDS THE EFFECTIVENESS OF THEIR DETECTION OR CORRECTION [SRAVNENIE PROIZVOLNYKH ADDITIVNYKH SHUMOV PO EFFEKTIVNOSTI IKH OBNARUZHENIYA ILI IZPRAVLENIYA]**
M. Ye. Deza 16 Nov. 1967 16 p refs Transl. into ENGLISH from Probl. Peredachi Inform. (Moscow), v. 1, no. 3, 1965 p 29–38
(AD-676631; FTD-HT-23-567-67) Avail: CFSTI CSCL 9/4

This article is a generalization of an earlier work in which the author investigated only the problem of the effective correction of noises for a binary case. The present work investigates the problem of a comparison, in a finite Abelian group, of all the additive noises of a prescribed capacity by the capacity of the maximum detection or correction codes. The capacities of the maximum codes, detecting or correcting the best or the worst noises of the prescribed capacity, are found with an accuracy with one order of magnitude; some of the characteristics of these noises are indicated. In the binary case, the problem of the comparison of the noises by the effectiveness of detection is solved completely. TAB

N69-13825# Atlantic Research Corp., Alexandria, Va. Jansky and Bailey Engineering Dept.
**TROPICAL PROPAGATION RESEARCH Semiannual Report, 1 Jul.–31 Dec. 1967**
Jan. 1968 174 p refs
(Contract DA-36-039-SC-90889; ARPA Order 371)
(AD-676870; SAR-10) Avail: CFSTI CSCL 17/2.1

The purpose of the Tropical Propagation Research Project is to investigate radio wave propagation in tropical environments. Its research is conducted through field measurement programs in Thailand that are followed up by mathematical analyses in the United States. This semiannual report describes recent experimental results from the projects second phase of tests. A section of heavy rain forest, identified as Area II in Figure 1.1, is the setting for the present tests. Begun in 1966, the second test phase is providing data to refine and expand conclusions drawn from an initial series of propagation tests. The initial phase of research, lasting from 1962 to 1966, was conducted in a region of medium heavy jungle, (Area I in Figure 1.1). The two other test locations, Areas A and B, that appear in Figure 1.1 are part of the initial research phase and consist of small plots of jungle used for short-range tests with frequencies at 550 Mc/s and above. Area A lies within Area I, and Area B was a section of bamboo growth on the sea coast. Author (TAB)

N69-13857# Syracuse Univ. Research Corp., N. Y. Systems Synthesis Lab.
**SIMPLE ANALYTICAL FUNCTIONS WHICH PROVIDE MAGNITUDES OF RANGE AND ANGLE ERRORS FOR PROPAGATION IN AN EXPONENTIAL ATMOSPHERE**
Lyall G. Rowlandson 19 Jan. 1968 36 p refs
(Contract F19628-68-C-0209)
(AD-676964; ESD-TR-68-308) Avail: CFSTI CSCL 17/9

The calculation of range and angle errors has been attempted by integrating the ray equations along the slant path and assuming an exponentially decreasing index of refraction with height. These equations are represented by error functions which are not simple analytical solutions. There is a further difficulty in relating the true elevation angle to the apparent elevation angle. The following paper shows how these equations may be modified to provide simple analytical functions. In the process the functions permit a range and apparent elevation angle term to be included which not only correct for the approximate solution at small angles but also generate functions which remain continuous through zero elevation angle. A comparison with ray-tracing calculations demonstrates that these functions can be used to compute meaningful magnitudes of range, elevation angle and doppler velocity errors. Author (TAB)

N69-13865# Signatron, Inc., Lexington, Mass.
**A STUDY OF THE RELATIONSHIP BETWEEN MULTIPATH DISTORTION AND WAVE NUMBER SPECTRUM OF DIELECTRIC NOISE IN RADIO LINKS Final Report, 1 Apr. 1966–30 Jun. 1968**
Phillip A. Bello Aug. 1968 126 p refs
(Contract AF 19(628)-5931)
(AD-676662; AFCRL-68-0439; SIG-TR-381) Avail: CFSTI CSCL 17/2.1

The study reported here is concerned with relating the multipath and frequency selective fading characteristics of radio links caused by scatter phenomena to the statistical spatial characteristics of the dielectric noise (or random refractive index). Two specific antenna configurations are studied in detail: the LOS (line-of-sight) case where the two antennas are pointed concentrically and the OTH (over-the-horizon) case where the antennas point along a great circle path. Single integrals and specific analytic and numerical examples are given relating frequency correlation functions and delay power spectra to the wave number spectra of assumed dielectric noises. It is shown that a measurement of the frequency correlation function or delay power spectrum can yield an estimate of the wave number spectrum of the dielectric noise. Author (TAB)

N69-13877# Rome Air Development Center, Griffiss AFB, N. Y.
**DIGITAL ERROR PATTERN ANALYSIS OF A CALIFORNIA TO NEW YORK HF RADIO TEST Final Report**
Donald G. Iram Sep. 1968 38 p refs
(AD-676265; RADC-TR-68-357) Avail: CFSTI CSCL 17/2

The error pattern data recorded on a transcontinental U.S. path are analyzed and the resultant statistics presented in a format that will allow comparison with similar tests performed on other H. F. circuits. The operation of the DPSK modem used in the test program is analyzed and the effect the modulation technique has on the error pattern is discussed. Conclusions are drawn as to the structure of the error patterns and the possible cause of the clustered errors experienced on this path. Author (TAB)

# 08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N69-12660# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**COMPUTER ENGINEERING, NO. 5**
24 Nov. 1967 339 p refs Transl. into ENGLISH from the book "Vychislitel'naya Tekhnika" Moscow, Mashgiz, 1966 275 p
(AD-676204; FTD-MT-24-295-67) Avail: CFSTI CSCL 09

Theoretical and experimental data are presented on developing computer circuits, and on the design of computers and their applications to automating data processing. Reliability engineering practices at all stages of design and manufacturing are also discussed. For individual titles, see N69-12661 through N69-12667.

**N69-12661#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ADDITION AND SUBTRACTION OF NUMBERS REPRESENTED BY A BINARY-DECIMAL CODE**

B. V. Anisimov et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 1–16 refs (See N69-12660 03-08)

Avail: CFSTI

Rules, algorithms and block diagrams of the digital computer operations of addition, subtraction, group operations and a general arithmetic unit are presented along with time diagrams of the operations in binary decimal code. A functional and schematic diagram of a single digit binary adder is given in detail. Author

**N69-12662#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**CERTAIN PHYSICAL PRINCIPLES OF THE CONSTRUCTION OF LOGICAL SYSTEMS FROM THIN MAGNETIC FILMS**

P. V. Nesterov et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 17–27 refs (See N69-12660 03-08)

Avail: CFSTI

The properties, design, and applications of magnetic thin film structures as storage and logic elements are considered in the light of recent improvements in thin film fabrication techniques and certain advantages inherent in magnetic thin films as compared to more conventional magnetic elements. The potential ease of manufacturing of large logic systems based on magnetic thin films, low power requirements, and response speed are some of these advantages. The introduction of single axis anisotropy insures stable orientation of the magnetic vector along this axis. If the magnetizing field coincides with the direction of the anisotropy, the hysteresis loop is rectangular. Hence, there are two stable magnetic states along this axis. The presence of a magnetizing field normal to the stable axis changes the value of the coercive force, degrades the shape of the hysteresis loop, and increases the speed of switching. Logic elements were fabricated from magnetic thin films (80% Ni, 17% Fe, 3% Co) 1500 Å thick, anisotropic field of 3.4 oersted, and coercive force of 2.4 oersted. Another application of mangetic thin films is in parametrons as a variable inductance of the resonance loop. Author

**N69-12663#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**CALCULATION OF RECTANGULAR DIODE DECODER**

B. V. Anisimov et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 29–36 refs (See N69-12660 03-08)

Avail: CFSTI

A rectangular decoder with three inputs is described. For reliable work of the decoder it is necessary that the transmission factor, the ratio of the least useful voltage drop to the greatest interference on the output, be greater than ten. Therefore, it is necessary to carefully consider the load impedence. Author

**N69-12664#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**PERMANENT MEMORY ON METAL CARDS**

A. V. Petrov et al *In its* Computer Eng., no. 5 24 Nov. 1967 p 37–50 refs (See N69-12660 03-08)

Avail: CFSTI

Principles, construction, and performance of a permanent electro-magnetic computer storage system based on perforated metal cards are discussed. The perforated, information carrying cards are made of copper, brass or duraluminum. The cards are patterned after their paper equivalents and have 45 columns with 3.2 × 8.35 mm perforations. One practical method of fabricating the two loop-planes is shown. The planes are made using printed circuits, such that each horizontal row of rectangular loops represents a 45-bit word and each vertical long rectangular loop senses the state of the particular bit in each word. A memory with a capacity of 3072 45-bit binary words was constructed from 256 separate cards. A diode decoding logic was used for card, row, and column selections. A description of the circuitry is included. Either sinusoidal or pulse signals can be utilized for excitation of the input loops. A blocking oscillator generates rectangular current pulses, allowing for an operation at a repetition rate of up to 5 MHz. The sinusoidal oscillator is designed for 1 MHz operation. An amplifier accepts the 5 Mv input pulses from the memory and provides 5 v output. Author

**N69-12665#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**MEMORY DEVICE WITH EXTERNAL ACCESS**

V. N. Sorokin et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 51–56 refs (See N69-12660 03-08)

Avail: CFSTI

A highly reliable transistorized two-cores-per-bit file memory designed to operate in data processing control systems is described. It consists of: a ferrite-core stack serving as the accumulator store; two address registers; a sampling circuit; a circuit for generating sampling current pulses; write drivers serving to shape powerful current pulses during data recording; an output signal amplifier; input and output registers; an overwriting circuit; and the operating-cycle control circuit. There are two cores per bit: a memory core (K-260 ferrite core, 2 × 1.4 × 0.8) and a switch core (VT 5 ferrite core, 3 × 2 × 1.4). The maximum switch time of any core does not exceed 4 msec. The coupling loop in the memory cell is made of PEV-2 wire 0.06 mm thick and about 10 mm in length so its resistance is ≈0.1 ohm; this has made it possible to markedly reduce the dimensions of the ferrite-core stack. The memory device is powered from a 24 v source. The power requirement of the entire device is ≈100 w. A model of this file memory was found to perform satisfactorily in the temperature range of from −10 to +50°C as well as with deviation of supply voltage by ±15% from rated voltage. Author

**N69-12667#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**CERTAIN PRINCIPLES OF THE CONSTRUCTION OF PERMANENT STORAGE DEVICES**

A. V. Petrov *In its* Computer Eng., No. 5 24 Nov. 1967 p 65–73 refs (See N69-12660 03-08)

Avail: CFSTI

Various types of permanent and semi-permanent digital data storage systems intended for read-only operations are described. The permanent storage systems include fixed matrices of electrical elements, e. g., diodes, resistors, transformers, capacitors; the semi-permanent storage systems also make use of matrices containing sensing devices, but the actual information storage is in terms of various switching mechanisms, perforated cards, patchboards and related devices. In the ferrite core, permanent memory variation of mutual inductance between the primary and the secondary windings of special transformers is used to indicate the 0 and 1 logic states. The transformers are arranged in an x-y matrix. The ferrite cores are inserted to increase the mutual inductance in every location where a logic 1 is desired. A read signal produces an output signal from the transformers with ferrite cores. A semi-permanent memory can be constructed utilizing metal cards. Each card is perforated in locations, where a logic 1 is to be indicated. This system is simple, inexpensive and fast. The drawback is the low level of the output signals, requiring high amplification. Ferrite strips can be used to enhance the signal-to-noise ratio, at the expense of greater complexity and fabrication difficulties. Author

**N69-12668#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CONSTRUCTION OF PULSE-TIME CONVERTERS OF VOLTAGE INTO CODE**
V. K. Zlobin *In its* Computer Eng., No. 5 24 Nov. 1967 p 75–87 refs (See N69-12660 03-08)
Avail: CFSTI

Algorithms, block diagrams, and circuitry are discussed for increase of conversion frequency; questions of pulse-time functional conversion; conversion of a time interval into code; and accuracy of pulse-time converters. Author

**N69-12669#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CONVERTER SHIFT-FIGURE WITH SCANNING GRIDS**
V. F. Shan'gin et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 89–102 refs (See N69-12660 03-08)
Avail: CFSTI

Principles and methods of precision incremental measurement of linear distances or displacements using coarse optical gratings to generate moire fringes are described. The optical density of the moire fringe pattern varies sinusoidally in the direction perpendiular to the fringes. This characteristic is advantageously used to sense the direction of the motion while counting whole fringes and their fractions. Four photocells are located under the stationary grating such that they are in a straight line and spaced in increments corresponding to 1/4 of one full fringe period, optical slits are placed between each cell and the gratings to define the small area to be monitored by each. In this arrangement, the motion of the vernier grating generates sinusoidal voltage outputs from each of the photocells, phaseshifted by 90° with respect to each other. An electronic system was designed to accept the inputs from the four photocells, to combine the signals representing the instantaneous fringe position and the direction of the motion, and to generate pulses on one of the two output terminals for every increment of displacement. Author

**N69-12670#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DEPENDENCE OF BASIC PARAMETERS AND STRUCTURE OF INFORMATION STORAGE SYSTEMS ON THE CHARACTERISTICS OF A DIGITAL COMPUTER**
Ye. I. Mamonov *In its* Computer Eng., No. 5 24 Nov. 1967 p 103–117 refs (See N69-12660 03-08)
Avail: CFSTI

The close interrelationship between the memory organization and access time and the efficiency of a digital computer is examined. The efficiency with which the computer time is utilized is shown to be a function of the memory access time. A computer instruction which is executed either by macro- or microprogrammed control in turn causes a different number of operations to be performed each requiring a certain number of memory accesses. The overall computer efficiency is shown to be influenced by such factors as the speed of the memory medium, parallel or serial organization of the memory and the arithmetic unit, recirculating or random access, and the mode in which the intermediate information is transferred between the main and the file memories. The effect of utilization of buffer memories between the memory and the arithmetic units is analyzed. The variable word length and content-addressable memories and their influence on the computer efficiency are also included in the discussion. Author

**N69-12671#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**APPLICATION OF CERTAIN METHODS OF INFORMATION THEORY IN THE TECHNOLOGY OF AUTOMATIC DIGITAL COMPUTING MACHINES**
Ye. I. Mamonov *In its* Computer Eng., No. 5 24 Nov. 1967 p 119–123 refs (See N69-12660 03-08)
Avail: CFSTI

The author negates the assumption by other workers in this field that the information on the output of a computer is not new information. It is the fact that a computer developes new information which distinguishes a computer from a transmission line. Likewise, whereas high operation speed is the ultimate goal of a transmission line, complexity of operations made on input data is the telling factor in automatic digital computers. Author

**N69-12672#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE QUESTION OF DESIGNING ELECTRONIC COMPUTERS WITH OPTIMUM RELIABILITY**
L. V. Surkov et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 125–132 refs (See N69-12660 03-08)
Avail: CFSTI

In electronic computers, cost can generally be expressed as a function of reliability of components and gross weight. A mathematical analysis is given in terms of a product series of unfailing work and a sigma series of unit weights to develop a Jacobi matrix, easily solved on usual computers, which gives minimum cost in terms of limited reliability and weight. Author

**N69-12673#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DIGITAL SIMULATION OF ELECTRONIC DIGITAL COMPUTER CIRCUITS**
I. P. Norenkov et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 133–144 (See N69-12660 03-08)
Avail: CFSTI

Mathematical models are derived for the numerous parameters which affect the operation of computer components, equivalent circuits of nonlinear components; a system of subprograms of nonlinear elements; and methods of decrease of machine time expenditures. Author

**N69-12674#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**FOUNDATION OF REQUIREMENTS OF RELIABILITY OF DEVICES DURING DESIGNING OF ELECTRONIC COMPUTERS OF OPTIMUM RELIABILITY**
L. V. Surkov *In its* Computer Eng., No. 5 24 Nov. 1967 p 145–156 refs (See N69-12660 03-08)
Avail: CFSTI

Equations of coupling, including a failure factor, give a system of equation which makes it possible to solve for minimum machine cost. Author

**N69-12675#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**METHOD OF ANALYSIS OF RELIABILITY OF SUBASSEMBLIES OF COMPUTERS AT THE PLANNING STAGE**
O. I. Lisov *In its* Computer Eng., No. 5 24 Nov. 1967 p 157–165 refs (See N69-12660 03-08)
Avail: CFSTI

Circuit diagrams, equivalent circuits, algorithms, and operational characteristics of trigger circuits, inverters, and collectors, with calculations of efficiency of each are presented. Author

**N69-12676#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DISTRIBUTION OF NORMS OF RELIABILITY ON SEPARATE ELECTRONIC DIGITAL COMPUTER DEVICES OF THE STAGE OF COORDINATION OF THE TACTICAL TECHNICAL ASSIGNMENT**

L. V. Surkov et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 167–172 refs (See N69-12660 03-08)
Avail: CFSTI

Two approaches are analyzed for achieving the efficient assignment of reliability norms to the various units of a digital computer, e.g., the arithmetic unit (AU), the control unit (CU), and the main memory unit (MU). The problem consists in finding the failure rate $\lambda_i$ of these units which will satisfy a given probability of machine failure Q(T) in time T. In the first approach the approximate failure rates are expressed as functions of the complexity of units and the relative failure rates of the components. The averaged failure rates and corresponding reliability factors $K_k$ (the ratio of the failure rate of a component to the failure rate of a resistor for a K-th type Ural-2 circuit) are presented. The reliability factors for the basic circuits of a Ural-2 computer, and the number of circuits per unit are also listed. A more realistic view of the failure rates of the units must take into account their manufacturing and operating costs. An expression is derived for finding the failure rate of individual units for which the cost of a unit is minimum taking into account the cost of the entire computer complex.
Author

**N69-12677#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE QUESTION OF CALCULATION OF ALLOWANCES OF ELECTRICAL CIRCUITS OF ELECTRONIC COMPUTERS**
P. P. Mesyatsev *In its* Computer Eng., No. 5 24 Nov. 1967 p 173–179 refs (See N69-12660 03-08)
Avail: CFSTI

Real parameters of electric components deviate from nominal values. Therefore, quadripoles can be represented not by the usual network but the sum of two networks, one representing nominal values and the second representing deviations from these values. The calculation is carried out by corresponding matrix equations.
Author

**N69-12678#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**OPERATIONAL AND RELIABILITY INDICES OF THE ELECTRONIC DIGITAL COMPUTER URAL-2**
B. I. Belov et al *In its* Computer Eng., No. 3 24 Nov. 1967 p 181–187 (See N69-12660 03-08)
Avail: CFSTI

The operation and reliability characteristics of the Ural 2 computer are discussed. The time spent on maintenance of four Ural 2 computers in different installations differed by as much as 350%. This discrepancy is assigned to the difference in the statistical methods used to evaluate their performance, environmental factors, and habits of operating personnel. Reliability figures are now presented for the Ural 2 computer at MVTU for 1963 and 1964 in which the low reliability period associated with the initial break-in period after installation (1961) was excluded. The location, number and cause of computer failure is shown for the period from May 1963 to April 1964 (total operating time: 3060 hr). The mean time between failures (MBTF) due to electronic, electromechanical, and accidental failures was 22.5, 37, and 37 hr. If the power supply failures are excluded from the first figure the corresponding MTBF due to average computer availability constituted 84% of the total time. Certain modifications for the more efficient preventive schedules and procedures are proposed.
Author

**N69-12679#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**TEST VARIANT FOR THE ELECTRONIC COMPUTER URAL-2**
I. P. Norenko et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 189–193 (See N69-12660 03-08)
Avail: CFSTI

Machine failure often remains undetected because of the general light nature of some routines or because of conditions under which error might be rounded off. A test run which can overcome this is offered in which a set of random numbers is run through one operation under heavy conditions, then run through another operation, etc.
Author

**N69-12680#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE QUESTION ABOUT CALCULATION OF RELIABILITY OF WORK OF ELEMENTS OF AN ELECTRONIC DIGITAL COMPUTER IN DYNAMIC CONDITIONS**
V. P. Panferov *In its* Computer Eng., No. 5 24 Nov. 1967 p 195–206 refs (See N69-12660 03-08)
Avail: CFSTI

Time response of a logical element is a function of the duration of pulses passed to its input. The critical frequency of transmission of information by such an element is that frequency whose pulse duration is so small that the probability of correct operation drops to the least permissible level. The critical operating frequency depends on the number of elements, range of change of delay, time of transition from one state to another and generally is much lower than the frequency of transmission of information.
Author

**N69-12681#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**QUESTIONS OF REPAIRABILITY OF ELECTRONIC DIGITAL COMPUTERS**
M. A. Titov et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 207–216 refs (See N69-12660 03-08)
Avail: CFSTI

In the overall digital computer reliability estimates, the repairability factors such as the detection, removal, and prevention of failures must be included in the analysis. These do not depend on the computer system organization, but on the capability of the maintenance personnel. The design of a computer system with a specific repairability figure is difficult since the statistical data for the new system is not available a priori. An attempt is made to correlate experience gained during the operation of a Ural-2 computer with the repairability design parameters for inclusion in future designs. Thus the computer availability time is related to the mean restorability time which in turn is shown to depend on a number of factors: computer functional organization (i.e. whether provisions are made for executing test programs), amount of equipment redundancy and built in control circuitry, location of fault indicators, structural organization (i.e. whether the structure is modular and access to measuring and test equipment is easy), organization of maintenance routines and schedules, and the qualification of maintenace personnel.
Author

**N69-12682#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**TESTS ON RELIABILITY AND APPRAISAL OF RELIABILITY OF AN ELECTRONIC COMPUTER ON THE BASIS OF OBTAINED INFORMATION**
B. I. Belov et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 217–231 refs (See N69-12660 03-08)
Avail: CFSTI

Three types of tests for a computer are (1) a test at nominal load, (2) accelerated tests at maximum permissible load, and (3) tests for determination of load limit. In this connection a method of statistical selection, and a method of successive trials for determining reliability during the period of running-in and subsequent operation are discussed.
Author

**N69-12683#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ANALYSIS OF IRREGULARITY OF CIRCUIT SUPPLY DURING USE OF PARABOLIC PARAMETRIC INTERPOLATORS**

B. V. Anisimov et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 233-240 (See N69-12660 03-08)
Avail: CFSTI

A mathematical formulation of errors due to supply circuits of parabolic parametric interpolators applied to cutting tools is derived. Author

**N69-12684#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**QUESTION OF PREPARATION OF INFORMATION FOR MACHINES WITH NUMERICAL CONTROL**

T. I. Abramova *In its* Computer Eng., No. 5 24 Nov. 1967 p 241-248 (See N69-12660 03-08)
Avail: CFSTI

A formulation of mathematical data applied to computers which control machine cutting tools, with special emphasis on sharp changes of curvature at reference points is presented. In addition to a table of reference coordinates, a table of reference angles should be provided. This is done simply by a calculation of derivatives at reference points, the result being a smoother contour at these reference points. Author

**N69-12686#** Air Force System Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ORGANIZATION OF A COMPUTING PROCESS OF AUTOMATIC PROGRAM PREPARATION FOR MACHINES WITH DIGITAL CONTROL**

T. I. Abramov *In its* Computer Eng., No. 5 24 Nov. 1967 p 255-265 (See N69-12660 03-08)
Avail: CFSTI

One of the difficulties in digital control of metal cutting machine tools is the writing of universal programs which require minimum modification when machine parts of different shapes are to be produced. The problem of formulating the programs for the trajectory of the metal cutting tool is reduced to the problem of finding the points of intersection of two circles, two lines, or a circle and a line, or the point of contact between two circles, line and, a circle, or the length of line segments between the points of intersection or contact or regular geometric figures. Four algorithms (including two with logical variables) and their coding methods for a Ural-2 computer are presented. These algorithms are sufficiently generalized and require no more memory space allocation than is available in computers such as Ural-2 or Minsk-2. When two items of different shapes are to be produced in succession, it is only necessary to enter data into the computer relating to the new geometry and the constants associated with the second object. Those portions of the program which are not needed in a specific case are automatically deleted. Author

**N69-12722#** Washington Univ., Seattle. Dept. of Psychology.

**THE FORTRAN DEDUCTIVE SYSTEM**

J. Ross Quinlan and Earl B. Hunt Jan. 1968 17 p refs
(Grant AF-AFOSR-1311-67)
(AD-676016; AFOSR-68-0818) Avail: CFSTI CSCL 9/2

A Fortran Program to solve generalized algebra type problems has been developed. It is a heuristic program, designed to give rapid solutions for problems which it can solve. The program accepts as input a definition of an algebraic system, then solves problems in the system. The programs operation is described here in general terms and examples of its operation are given. Author (TAB)

**N69-12769#** Stanford Linear Accelerator Center, Calif.

**AUTOMATIC FILM DIGITIZER PERFORMANCE AND PLANS AT SLAC**

J. Brown Jul. 1968 16 p Presented at Intern. PEPR Colloq., Nijmegen, Neth., 5-7 Jun. 1968 Supported in part by AEC
(SLAC-PUB-426; CONF-680628-1) Avail: CFSTI

A description of the hardware and software used in the automatic data analysis of spark chamber pictures at SLAC and a report on the results are presented. Plans for the analysis of bubble chamber pictures are outlined briefly. Author (NSA)

**N69-12813** Arizona State Univ., Tempe.

**MACHINE-INDEPENDENT ASSEMBLERS FOR COMPUTING SYSTEMS**

Myron Ammon Calhoun (Ph.D. Thesis) 1968 245 p
Avail: Univ. Microfilms: HC $11.05/Microfilm $3.20 Order No. 68-1647

A solution to the perplexing problem of writing a symbolic assembler which is readily translatable into the instruction repertoire of most digital computers is developed. The technique described isolates and identifies those characteristics of a binary, fixed word-length, single-address, stored-program, general-purpose digital computer which are pertinent to the production of machine-language instructions. In particular, a set of instruction "signatures" was developed to describe completely the contents and the positional relationships of the contents of most computer instructions with a minimum number of bits of information. A "functional" description of a reasonably complex symbolic assembler was produced and a program written to translate and collate the given characteristics and the functionally-described assembler into the machine language of any specific computer. Sample object assemblers for two separate computers were produced using the method described. The procedure is suitable for "bootstrapping" a software system into a computer. Dissert. Abstr.

**N69-12942#** Atomics International, Canoga Park, Calif.

**STORAGE OF MICROSCOPIC CROSS-SECTION DATA IN THE AIENDF**

R. F. Berland and R. A. Blaine 31 Jul. 1968 116 p ref
(Contract AT(04-3)-701)
(NAA-SR-11980-Vol-2) Avail: CFSTI

The data storage and retrieval techniques for microscopic cross-section data are described. Instructions are given for using MOMUS and TOAD programs, which are written in FORTRAN H for the IBM 360 computer. The MOMUS Program is used to construct and maintain the microscopic neutron cross-section library, and the TOAD Program is used to construct and maintain the differential neutron angular distribution data library. Author (NSA)

**N69-12987** Wisconsin Univ., Madison.

**DDL: A DIGITAL SYSTEM DESIGN LANGUAGE**

James Robert Duley (Ph.D. Thesis) 1967 221 p
Avail: Univ. Microfilms: HC $10.15/Microfilm $3.00 Order No. 67-12116

A precise, concise language is presented that facilitates the design of digital systems in much the same way FORTRAN expedited programming for numerical analysis ten years ago. The symbolic, mnemonic approach is used to achieve precise, concise specifications of complex digital systems. The syntax and semantics of the language have been constructed to permit DDL documents that parallel the block structure of such systems. The language allows specification at different design levels from initial architecture to detailed Boolean equations and in various timing modes from synchronous to asynchronous. The syntax and semantics of DDL are accurately defined and the pragmatics of the language are demonstrated through extensive examples. In addition, transformations are presented to permit the logic equations to be compiled from any DDL document. Dissert. Abstr.

N69-13071* Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**PROCESSING AND TRANSMISSION OF INFORMATION**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 147-151 refs
(See N69-13060 03-34)
(Grant NsG-334)
Avail: CFSTI CSCL 09D

Studies in convolutional coding included work on the Plotkin bound for convolutional codes, semidefinite decoding, and the Gilbert bound on definite decoding distance. A theorem proof is presented for convolutional codes with symbols in an arbitrary finite field. A semidefinite decoding procedure was suggested which allows the decoder to make some use of previous decoding decisions without danger of infinite error propagation, which can arise when feedback decoding is employed. This type of decoding was described in terms of the syndrome register used in the decoder.
B.P

N69-13126# Uppsala Univ. (Sweden). Inst. of Physics.
**MULTICHANNEL PULSE HEIGHT ANALYZER WITH DIGITAL ADDRESS AND ANALOG MEMORY**
A. Westman, E. Petrusson, and P. A. Tove Jun. 1968 8 p
(UUIP-596) Avail: CFSTI

An investigation is presented on the performance of an analog memory for multichannel pulse height analysis. The memory consists of 64-$\mu$F memory capacitors connected to junction FET switches which are controlled from a diode matrix fed from two series-connected scales-of-eight. The first of these receives the addressing pulses, which are obtained from a pulse-height to digital converter. The pulse processing time is 64 $\mu$sec. The decay of a stored spectrum is of the order of 2 percent for 24 hours. The differential linearity is at present limited by inequality of capacitor values (2 percent) but it is possible to bring this down to below the statistical uncertainty at the highest count number. A maximum of $10^5$ stored pulses per channel were used. The potential advantage of the system is an economical construction, especially if integrated techniques are used, and the speed, which could be increased one order or magnitude and more, relative to the figure quoted above.
Author (NSA)

N69-13195 Washington Univ., St. Louis, Mo.
**SOLVING NONLINEAR INEQUALITIES BY RELAXATION WITH APPLICATIONS TO NONLINEAR PROGRAMMING**
Daniel Edward Cullen (Ph.D. Thesis) 1967 86 p
Avail: Univ. Microfilms: HC $4.60/Microfilm $3.00 Order No. 67-17165

New results in nonlinear optimization theory are presented. The research attacked the general problem in which global rather than local optima are sought, a problem which has defied solution in all but special cases. This dissertation presents two algorithms which provide a systematic search for global optima. The form of the methods is such that they are directly applicable to the solution of nonlinear inequalities . The basic algorithm is a generalization of the Relaxation Method for solving linear inequalities. The manner of generalizing to the nonlinear case and the procedures for converting to a mathematical programming format are shown. Variations in this algorithm are also shown. A theorem is proven which shows that whenever an inequality problem is bounded, divergence of the method implies there is no solution to the problem. A second algorithm, incorporating the assumption of boundedness, is advanced.
Dissert. Abstr.

N69-13378# Royal Aircraft Establishment, Farnborough (England).
**SIMPAC: A FAST-TIME SIMULATION PACKAGE BASED ON ALGOL**
A. A. Calloway May 1968 35 p refs
(RAE-TR-68127) Avail: CFSTI

The simulation of a system which is activity-oriented, where the real-life situation is one of discrete change or if its behavior is predictable between events, such as, for example, in the air traffic control environment, can be studied by investigating the behavior of a probabilistic model which advances its simulation time in irregular steps from event to event. A method is described by which such simulations may be performed using a language which has not evolved significantly far from its parent Algol and, therefore, presents no learning barrier to someone familiar with Algol. A complete programmed example is included to illustrate the use of the method.
Author (ESRO)

N69-13463# Atomic Weapons Research Establishment, Aldermaston (England).
**MAP, TIME SERIES, AND OTHER PLOTTING ROUTINES FOR USE WITH THE STROMBERG-CARLSON 4020 PLOTTER**
J. B. Young and A. Douglas Jul. 1968 76 p refs
(AWRE-O-41/68) Avail: CFSTI

Six plotting packages for use with the SC4020 plotter with the IBM 7030 computer are described. Three of the packages are for plotting maps, two for plotting time series and one for general cartesian coordinate graphs. A routine for drawing dotted lines is also described.
Author (NSA)

N69-13538# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ABOUT CERTAIN PRINCIPLES OF IDENTIFICATION OF IMAGES [O NEKOTORYKH PRINTSIPAKH RASPOZNAVANIYA OBRAZOV]**
A. A. Feldbaum Nov. 1967 16 p refs Transl. into ENGLISH from Samcobuchayushchiesya Avtomat. Sistemy (USSR), 1966 p 73-80
(AD-678558; FTD-MT-24-292-67) Avail: CFSTI CSCL 9/2

In most existing systems instructed to recognize patterns, recognition is an instantaneous act performed by a certain logic process. Therefore, such instructed systems can be called static. However, when working out recognition systems there is another approach which is not without promise. This approach lies in constructing dynamic instructing recognition systems in which recognition is not an instantaneous act, but some process. The important prospects opened by this approach are explained by the following considerations: (1) Any picture or image represents not a simple totality of its elements but an ordered totality. (2) Recognition of images by man or by an animal is a process encompassing an entire complex of links of the visual or tactile organs of sense. The task of the investigation which served as the basis for this article did not include an attempt to simulate the processes of recognition occurring in a living organism, but certain concepts of these processes can prove to be beneficial when developing new types of automatons, in particular dynamic instructing systems of recognition.
TAB

N69-13566*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**A SET OF 360 FORTRAN (LEVEL G OR H) SUBROUTINES FOR GENERATING PRINTED PLOTS**
Lois T. Deliner Washington 1968 71 p refs
(NASA-TM-X-1700) Avail: CFSTI CSCL 09B

A set of subroutines, written in 360 FORTRAN IV (level G or H), easy for the FORTRAN programmer to use, provides printed plots as part of normal output. These subroutines are simplified so that no choices must be made and generalized so that choices may be made by the programmer of the plotting characters, the scales, the appearance of the grid, and other options. The FORTRAN routines generate ordinary output records (up to 132 characters) suitable for on- or off-line printing.
Author

**N69-13575#** Case Western Reserve Univ., Cleveland, Ohio. Systems Research Center.

**A MODEL OF CONCEPT LEARNING Interim Scientific Report**

Richard H. Sherman Jun. 1968 86 p refs

(Grants AF-AFOSR-125-67; NSF GK-1386)

(AD-676294; SRC-68-8; AFOSR-68-2084) Avail: CFSTI CSCL 9/2

A learning program designated CE, Concept-EPAM, is described that modifies EPAM through the introduction of a set membership relation. The effects of this extension are considered with respect to methods of storing concept descriptions in memory and methods of specifying learning and retrieval. The learning strategies consist of interactions between image elaboration and tree modification. Implementations of CE are considered for a concept learning task and a pair associate task. Applicability of CE to a geometry analogy task requiring relational concepts is discussed. The relationship between the learning of concepts of concepts and feature extraction is illustrated. Author (TAB)

**N69-13619#** Australian Aeronautical Research Committee, Melbourne.

**DEVELOPMENT OF DIGITAL AND ANALOGUE SYSTEMS OF DECODING PULSE WIDTH MODULATED DATA**

K. F. Fraser Jan. 1968 66 p refs

(ARL/INST-25) Avail: CFSTI

A flight data decoder has been developed which, in conjunction with some commercial equipment, demodulates the data signal which is separated, on playback, from a composite speech plus flight data recording taken with Flight Memory Airborne Equipment. In the recording of the flight data, sampled data signals modulate the width of pulses which in turn gate a sinusoidal oscillator. Automatic presentation of the decoded flight data information, in either digital or analog format, is possible using the decoder. Author

**N69-13627#** Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.

**ABSOLUTE SYMBOLIC ADDRESSING: A STRUCTURE MAKING TIME-SHARING EASIER [ADRESSAGE SYMBOLIQUE ABSOLU, STRUCTURE FACILITANT LE TRAVAIL EN PARTAGE DE TEMPS]**

Pierre Debraine (Inst. Natl. des Sci. et Tech. Nucl.) Aug. 1968 63 p refs In FRENCH; ENGLISH summary

(CEA-R-3588) Avail: CFSTI

Time-sharing of computers asks for a certain number of conditions, particularly an efficient dynamic loading of programs and data. A paging method is indicated making linkages with a minimum of table-looking operations. The principle is to use associative memory registers for calling blocks of physical memory, the block address being given by the concatenation of a file number (located in a base register) and a page number (located in the instruction proper). The position within the block is given by a displacement located in the instruction. A second associated base register contains the local part (page number + displacement) of the base address. This extended base register system allows for performance of programs in a very large programming complex without loss of time. The addresses are fixed at assembly time and the blocks can be loaded anywhere without modification for execution. The various problems associated with the execution of complex programs are presented in this context and shown to be easily solved by the proposed system, the realization of which would be very easy starting from the computer structures existing now. Author (ESRO)

**N69-13663#** Laboratory for Electronics, Inc., Boston, Mass. DTPL Lab.

**PUSH DOWN LIST MEMORY (PUDL), VOLUME 2 Final Report, Mar. 1966–Aug. 1968**

Michael J. Marino and John Veronelli Aug. 1968 147 p refs

(Contract AF 19(628)-4197)

(AD-676859; AFCRL-68-0403) Avail: CFSTI CSCL 9/2

The principles of operation of Domain Tip Propagation Logic (DTPL) and its application to thin film all-magnetic logic have been described in previous papers. The controlled growth and interaction of domain tips, confined to narrow, low coercive force propagation channels within a film element of generally high coercive force, were shown capable of being utilized to perform all digital logic functions and to implement high-speed, bidirectional magnetic shift registers. In order to determine the feasibility of a DTPL implementation of a Push Down List Memory (PUDL), an 8 list, 25 word/list, 13 bit/word feasibility model was designed, constructed, and demonstrated. This report describes work which was carried out on the design of the feasibility model. Investigations were made on the basic PUDL thin-film shift register structure as well as the associated conductor patterns. Drive and sense electronics and the PUDL system has been studied and evaluated. The general feasibility of the DTPL implementation of a Push Down List Memory is demonstrable, the question of the cycle time, a factor, which requires additional work and optimization of the thin film elements. Author (TAB)

**N69-13821#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ON THE ACCURACY OF CALCULATING CORRELATION COEFFICIENTS BY THE OPTICAL METHOD [O TOCHNOSTI VYCHISLENIYA KOEFFITSIENTOV KORRELYATSII OPTICHESKIM SPOSOBOM]**

V. K. Eliseev Oct. 1967 16 p refs Transl. into ENGLISH from Chitayushchie Avtomaty i Raspoznavanie Obrazov (Kiev), 1965 p 126–137

(AD-676498; FTD-HT-23-964-67) Avail: CFSTI CSCL 9/2

A theoretical study is presented of the effect of contrast of pictures being recognized and standard masks upon the accuracy of computation of correlation coefficients. It is assumed that contrast variations are caused by linear transformations, and that the relative error of measuring luminous fluxes is specified. Formulas are developed for evaluating the accuracy of optical calculation of correlation coefficients for any set of standards and for determining the effect of contrasts on this accuracy. This permits formulating specifications for the measuring optical correlators and the standard masks. Curves plotted on the basis of experiments with Moskva typewriter texts permit carrying out all calculations connected with the recognition of this typewriters characters. An example has shown that an instrument error of 1% and a contrast of 10 or better are required in order to ensure an error probability of 0.0001 for the hard, first and second carbon copies. The results of this study are claimed to be applicable to any automatic reader in which the error is calculated as a difference of signals of two measuring channels. TAB

**N69-13836#** Boston Coll., Chestnut Hill, Mass. Space Data Analysis Lab.

**ANALYSIS OF DATA FROM OV3-2, GEMINI 10, GEMINI 12 AND SNAPSHOT SATELLITES Final Report, 1 Jan.–31 Dec. 1967**

Rene J. Marcou, Paul N. Pruneau, Robert W. Ficretti, and Karen Lemone 31 Jan. 1968 54 p refs

(Contract F19628-67-C-0113)

(AD-676789; AFCRL-68-0427) Avail: CFSTI CSCL 9/2

Plots and listings generated by computer programs are made use of to determine the aspect of the Gemini 10 and 12 manned satellites. The aspect analysis which makes use of telemetered data from an onboard ion-sensing system as input to the computer programs was furnished by the AFCRL. The computer program output for Gemini 10 and 12 is exhibited in plots given in the appendix (Figures 1-15). SECTION 2 Sun sensor and earths magnetic field telemetered data together with the general analysis

and the accompanying computer program are made use of to determine the aspect of the satellite OV3-2 for revolution 1125. The aspect is exhibited by plots of the angle between the axis of the spacecraft and the equatorial plane, the angle between the projection of the axis in the equatorial plane and the vernal equinox line, the angle of attack of the axis with the velocity vector (from both the raw data and from the smoothed aspect data), and the angle of attack of the axis of the spacecraft with the earths magnetic field vector. SECTION 3 Plots and listings generated from the Standing Wave Impedance Probe and the Retarding Potential Analyzer data of the OV3-2 satellite are used to determine the electron current, electron density, and electron temperature of the atmosphere. SECTION 4 Plots and listings generated from the various experiments of the Snapshot satellite were used to determine the following: the electron density from the Standing Wave Impedance Probe; the vehicle potential, the ion and electron currents, fluxes, and densities from the Plasma Probe; and the currents, pressures, and number densities from the Ion Density Gauge.
Author (TAB)

**N69-13858#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CONCERNING THE OPTIMUM QUALITY OF AN ARITHMETIC UNIT OF A TRANSLATOR [K VOPROSU OB OPTIMALNOSTI ARIFMETICHESKOGO BLOKA TRANSLYATORA]**
V. I. Fasenko Oct. 1967 12 p refs Transl. into ENGLISH from Izv. Akad. Nauk Moldavsk. SSR (Kishinev), no. 7, 1965 p 108–113
(AD-676543; FTD-MT-24-288-67) Avail: CFSTI CSCL 9/2

The report considers problems on translation of arithmetic expressions. A version of the address language described in E. L. Yudenkos report entitled Address programming (Tekhizdat UkrSSR, 1963) is used as the input language. The author introduces some supplemental considerations in defining the address function as given by M. M. Bushko-Zhuk in Defining the address function and the principles of compiling programming programs (Izv. AN MSSR, 1962, No. 5). These modifications permit the use of mildly parenthetic writing in constructing a translator. Consideration is also given to a problem on economy of operating cells through allowable rearrangements of components (cofactors). TAB

**N69-13867#** Atomic Energy Commission Research Establishment, Riso (Denmark).
**DIGITAL DATA XY PLOTTER WITH DATA SORTING CAPABILITIES**
K. B. Hansen Apr. 1968 25 p refs
(RISO-173) Avail: CFSTI

The digital data XY plotter described is used as an output unit in digital instrumentation systems. Identifying characters in the serial by character output from the systems are used to sort out the data to be plotted. The numerical characters are assembled in a shift register, transferred to a buffer register and converted to the analog form. The recorder is a conventional XY analog plotter with zero detector. Author (NSA)

**N69-13885*#** National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
**SPACE SCIENCES DATA PROCESSING**
G. H. Ludwig Paris ESRO Oct. 1967 36 p refs Presented at the Joint ESLAB/ESRIN Symp. on Satellite and Rocket Meas. of Corpuscular Radiation from Outer Space, Noordwijk, Neth., 10–14 Jul. 1967 Sponsored by ESRO
(NASA-TM-X-61402; ESRO-SN-78) Avail: CFSTI CSCL 09B

The task of processing data rapidly and accurately is a very large one, and is done in several steps. The first includes conversion of the raw data acquisition station tapes into computer tapes and includes signal clean-up, establishment of synchronization, and time decoding. In the newest processing lines this first step also includes a moderate amount of editing and quality-checking. The rest of the steps employ large-scale computers for further editing, establishment of accurate timing, computation of the spacecraft attitude, and sorting, to provide data tapes for the individual experimenters. The experimenters have the responsibility at present for the further reduction to more meaningful form. These operations include further sorting, storage, compilation, computation, and display. There is at present a great need for additional development of analysis and display programs, techniques, and equipment to assist in this work. Author (ESRO)

# 09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

**N69-12866#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**EQUIVALENT CIRCUIT OF TRANSISTOR WITH COMMON EMITTER AT LOW FREQUENCIES**
Yu. V. Vinogradov *In its* Computer Eng., No. 5 24 Nov. 1967 p 57–64 (See N69-12660 03-08)
Avail: CFSTI

Through an analysis and conversion of Y-and h-parameters given in handbooks for transistors, a system of equations and an equivalent circuit for a transistor with common emitter at low frequencies are developed. Author

**N69-12758#** Joint Publications Research Service, Washington, D. C.
**ELECTRON SHOCK PHENOMENA ON THE ANODE OF A PULSE X-RAY TUBE**
K. F. Zelenskiy et al *In its* Res. in Tech. Phys. 26 Nov. 1968 p 72–81 refs (See N69-12751 03-25)
Avail: SOD/CFSTI

The operating physics of a two-electrode pulse X-ray tube with an "inverted" cathode fed by a capacitor impulsing circuit at a voltage of 3200 kV and an operating capacitance of 6200 $\mu\mu$ F was investigated. The velocity and temperature of the metal vapor and discharge plasma from the electrodes of the tube were measured for various anode diameters. It was shown that on decreasing the anode diameter from 30 to 0.3 mm, the velocity of the anode plasma increases from 3 to 20 km/sec, and the temperature increases to 19,500 ° K. Experimental data were obtained on the nature of the electron distribution on the anode and the duration of the X-ray flash. It was demonstrated that under the effect of the proper magnetic field of the tube current, which reaches an intensity of several kOe for currents of 10–20 kA, the electrons are ejected out of the cathode cut to the face of the anode. Author

**N69-12924#** Uppsala Univ. (Sweden). Inst. of Physics.
**DIODE CHARACTERISTICS OF HIGH RESISTIVITY SURFACE BARRIER SILICON DIODES**
P. A. Tove, M. Madakbas, W. Seibt, and W. Leitz Mar. 1968 31 p refs
(UUIP-597) Avail: CFSTI

The current-voltage characteristics of high resistivity silicon surface barrier diodes have been measured and correlated with expected behavior. The resistivity of the n-type silicon ranged from 500 Ωcm to 20 kΩcm, and different evaporated metals for the rectifying and ohmic contacts were investigated. The function of a single contact is discussed in terms of current components of

different orgin, such as Schottky current, bulk and surface generation-recombination current, diffusion current, and current arising at the edge regions. It is shown that for metals that tend to give high barriers, such as Au and Sb in the back region the voltage-dependent currents from surface generation are moderately pronounced. For metals that tend to give more or less ohmic contacts such as Al, Mn, and In the Schottky component predominates and the correponding Schottky saturation current becomes higher for metals with low work functions.
Author (NSA)

**N69-13138#** Los Alamos Scientific Lab., N. Mex.
**INTEGRATION OF ULTRASONIC BOND SIGNALS**
N. B. Edenborough [1968] 13 p Presented at the 28th Natl. Fall Conf. of the Am. Soc. for Nondestructive Testing, Detroit, 14–17 Oct. 1968
(Contract W-7405-Eng-36)
(LA-DC-9383; CONF-681004-1) Avail: CFSTI

A circuit is described which integrates the ultrasonic signal from a bonded joint. This circuit is capable of measuring the percent of bond over any size area. Used in the circuit is a voltage-to-frequency converter which converts the analog gate signal to a frequency and a pulse counter. The number of pulses received over a length of scan is a function of the percent of bond.
Author (NSA)

**N69-13227*#** Electro-Mechanical Research, Inc., Princeton, N. J. Photoelectric Div.
**IMPROVED STERILIZABLE MULTIPLIER PHOTOTUBES Final Report**
E. J. Dumas and M. Rome 28 Jul. 1968 32 p Prepared for JPL
(Contracts NAS7-100; JPL-951555)
(NASA-CR-97903) Avail: CFSTI CSCL 09A

A multiplier phototube with visible response has been developed for use in scintillation counting applications where sterilization is required. The sterilizable phototube, the EMR Model 549A-4476, utilizes a newly developed, properietary photocathode which has a high sensitivity in the blue well matched to the emission spectrum of NaI(Tl). This photocathode has good stability when exposed to the sterilization environment. A test sample of four phototubes was subjected to three sterilization cycles of 145° C for 36 hours each. Test results are discussed.
Author

**N69-13230*#** Litton Industries, San Carlos, Calif. Electron Tube Div.
**ANALYTICAL STUDY PROGRAM TO DEVELOP THE THEORETICAL DESIGN OF SPACE BORNE ELECTROSTATICALLY FOCUSED KLYSTRON AMPLIFIERS Final Report**
W. R. Day and T. H. Luchsinger [1968] 124 p refs
(Contract NAS3-11515)
(NASA-CR-72449) Avail: CFSTI CSCL 09A

The objective was to extend the electrostatically focused klystron (ESFK) art to permit the design of considerably higher efficiency amplifiers for operation in a space environment. Primary emphasis was placed on the critical problems of obtaining higher efficiency and adequate heat transfer while maintaining long operating life, small size and light weight. Voltage jumps, extended interaction output resonators, low perveance electron beams and multistage depressed collectors were found to afford a solution to the problem of efficiency enhancement in ESFK's. A transverse-field depressed collector was conceived which promises to permit high efficiency amplification of AM signals as well as FM signals. The problem of heat transfer associated with spaceborne ESFK's was solved by using a liquid potassium heat pipe radiator operating at 500° C. Electrical and mechanical designs were made for ESFK's intended for TV satellite applications at 0.85, 2.0 8.0 and 11.0 GHz.
Author

**N69-13251*#** Connecticut Univ., Storrs. Dept. of Electrical Engineering
**ANALYTICAL AND EXPERIMENTAL STUDY OF REENTRANT STREAM CROSSED-FIELD AMPLIFIERS Final Report**
G. E. Dombrowski and W. C. Price Jul. 1968 130 p
(Contract NAS3-9710)
(NASA-CR-72442) Avail: CFSTI CSCL 09A

Electronic interaction in an injected beam forward-wave amplifier was analyzed by simulation in a digital computer. Gains as high as 15 db with efficiencies in the range of 50 to 70 percent can be attained with a proposed design which uses a network 6 wavelengths long. Attempted simulation of high gain operation with low rf input signals was hampered by instability. Studies of a second design of the amplifier, using 13 wavelengths, show higher gain and greater computational stability with less stream feedback. Early indications are that the efficiency of this design is greater. The analysis of the injected reentrant beam crossed-field amplifier is not complete. Amplitron noise power measurements were made on type QKS-1300 tubes. Spectral density of total noise was found to be −68 dbm/Hz for a broad range of frequency in the Amplitron pass band.
Author

**N69-13394#** Etablissement d'Etudes et de Fabrications d'Armement, Bourges (France).
**HIGH CURRENT PYROTECHNIC CONNECTOR FOR SPACE APPLICATIONS [CONJONCTEUR PYROTECHNIQUE EMBARQUABLE POUR TRES FORTE INTENSITE]**
M. B. Ceyrat and A. Winavert 1968 18 p In FRENCH Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

A pyrotechnical connector designed to transfer high energy in a very short time is described. The device consists of a liquid metal jet which penetrates the metal coating of the electrode. The effect of the aerospace environment on the device is discussed.
ESRO

**N69-13490#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**USING ACID-RESISTANT PHOTOSENSITIVE EMULSIONS TO OBTAIN LOCAL INHOMOGENEITIES WITH A HIGH RESOLVING POWER ON MONOCRYSTALS AND FILM GERMANIUM AND SILICON [PRIMENENIE KISLOTOSTOYKHIKH SVETOCHUVSTVITELNYKH EMULSII DLYA POLUCHENIYA LOKALNYKH NEODNORODNOSTEI S VYSOKIM RAZRESHENIEM NA MONOKRISTALLAKH I PLENKAKH GERMANIYA I KREMNIYA]**
Yu. I. Fedorov et al 3 Nov. 1967 18 p Transl. into ENGLISH from the book "Poverkhnostnyye i Kontaktnyye Yavleniya V Poluprovodnikakh" Izd-Vo Tomskogo Univ., Tomsk, 1964 p 476–490
(AD-676533; FTD-HT-23-610-67) Avail: CFSTI CSCL 14/5

Photosensitive acid-resisting emulsions for use in photoengraving of semiconductor parts and semiconductor surfaces were synthesized and tested. Etching agents were prepared for use on germanium and silicon, films of germanium and silicon, silicon oxides, and gallium arsenide single crystals. Sensitizers that increase the sensitivity of the emulsions to ultraviolet light are indicated. Over 20 preparations--including natural colloids, organosilicon compounds, cinnamic aldehyde, emulsions based on azo and diazo compounds and polymeric polyesters--were tested. The photoengraving method consists of preparation of surfaces, application of emulsion, exposure, development, heat tanning, ultraviolet tanning, etching, and washing and drying. It was found that the esters of polystyrene and cinnamic acid, polyvinyl alcohol, and cinnamic acid have high dielectric characteristics that change

negligibly with time. It was also found that some of the resins that were synthesized are universal for photoengraving emulsions for the above-mentioned semiconductor materials. The sensitized emulsions that were used retained their ability to be tanned by ultraviolet rays for several months. Author (TAB)

**N69-13534*#** Isomet Corp., Palisades Park, N. J.
**STERILIZABLE OPTIDAL DETECTOR SCINTILLATION CRYSTAL ASSEMBLY Final Report, 15 Nov. 1965–30 Apr. 1967**
23 Sep. 1968 50 p Prepared for JPL
(Contracts NAS7-100; JPL-950982)
(NASA-CR-97897; REPT-5100-FR) Avail: CFSTI CSCL 09E

A study was made of available solid state diodes useful for detecting low light level signals from scintillation crystals. The Ortec, Model 105 charge sensitive amplifier was used to detect the output from the photodiode. The state-of-the-art of both diode and amplifier was such that the assembly was not detector-noise limited, as is desirable. A prototype scintillation crystal solid state device assembly was designed, fabricated, and tested. No observable signal was detected over 12 MeV electrons from a Van de Graaf generator. An analysis of the results was made but it was not possible to determine what contributed to the high threshold. Author

**N69-13574#** Forschungslaboratorium, Wiesbaden (West Germany).
**INVESTIGATION OF $Cs_2O$-PHOTOCATHODES (TYPE S 1) Final Technical Report, Mar. 1967–Feb. 1968**
Walter Heimann, Evgen Kansky, and E. L. Hoene Jun. 1968 70 p refs
(Contract DAJA37-67-C-0492)
(AD-676292) Avail: CFSTI CSCL 9/1

The report discusses four subjects: Preparation of S1 layers having a thermal emission of 10 to the -15th power A/sq cm and a photosensitivity of 0.001 mA/mW at 900 nm in image converters; investigation of the quantitative composition of (Rb, Cs) oxide cathodes and the reason for their instability; gravimetric investigation of the quantitative composition of Cs2O-cathodes and measurements to determine their emission mechanism; preparation of screens using a new method for implantation of the phosphor. TAB

**N69-13613#** Army Electronics Labs., Fort Monmouth, N. J.
**BROADBAND TRANSFORMER DESIGN FOR RF TRANSISTOR POWER AMPLIFIERS**
Octavius Pitzalis, Jr. and Thomas P. Couse Jul. 1968 35 p refs
(AD-676816; ECOM-2989) Avail: CFSTI CSCL 9/1

Various forms of broadband transmission line transformers for use through VHF and concepts basic to their operation are summarized and described. Broadband power adding and power dividing hybrids for push-pull amplifiers and parallel additive uses are given similar attention. The design of broadband input and output matching elements for a single-ended stage using a 2N5071 transistor for 30 W of output power from 30 to 80 MHz is illustrated. Useful curves for guiding the design of 4:1 transformers with resistive loads are given. Curves showing typical input impedance versus frequency of a pair of cascaded 4:1 transformers loaded by the large signal R-L-C equivalent input circuit of the 2N5071 are included. The use of hybrids to operate a pair of these transistors in push-pull operation is described. Author (TAB)

**N69-13615#** Bendix Corp., Southfield, Mich. Research Labs.
**SOFT X-RAY DETECTORS Final Technical Report, 1 Jan.–31 Dec. 1967**
Toivo A. Somer Wright-Patterson AFB, Ohio AF Mater. Lab. Aug. 1968 52 p refs
(Contract F33615-67-C-1046)
(AD-676297; AFML-TR-68-188) Avail: CFSTI CSCL 9/1

The relative quantum efficiencies of various photocathode materials were studied in the soft X-ray region. Using the monochromatic line of Al K sub alpha with Au, Al, Cr, CaI, NaCl, and MgF2 photocathodes, the angular dependence of the photoelectric yield was studied. These measurements were performed with the recently developed Spiraltron (TM) photon detector, a windowless electron multiplier characterized by high gain and a Gaussian gain distribution for single photon/electron inputs. The detector response to Cu target radiation, including the CuL sub alpha line, is compared to the flow proportional counter response. The location of the absorption edges for the photocathodes are determined and it is concluded that the photocathodes are useful only in spectral regions free of photocathode absorption edges. In addition to the Spiraltron photon detector, an MEM with a replacement photocathode was provided. This MEM can also be used as a photon detector in this spectral region when operated at near grazing incidence. Author (TAB)

**N69-13678#** Army Electronics Command, Ft. Monmouth, N. J.
**PULSE DURATION EFFECT ON PLASMA RESISTIVITY**
John E. Creedon and Sol Schneider Jun. 1968 17 p refs
(AD-676840; ECOM-2984) Avail: CFSTI CSCL 9/1

At the Ninth Modulator Symposium the resistivity of high-current discharges in hydrogen was discussed. At that time, the pulse-width dependence had not been studied, and it was believed that the resistivity was essentially independent of pulse width until thermal conduction and radiation heating of the wall introduced impurities. Further measurements were made on 3-inch diameter tubes with electrode spacings ranging from 2 to 22 inches. The pulse duration used was 56 microseconds as compared to 28 microseconds for the previous study. The resistivity was calculated from the tube drop versus current measurements. A comparison was made with the resistivities predicted from electron density and temperature measurements obtained from Stark broadening and line intensity ratio techniques. It was determined that a gas temperature correction had to be made for the pressure dependent term of the predicted resistivity. The temperature correction was directly proportional to the power dissipated in the gas discharge. It was concluded that in long pulses gas heating effects can increase the plasma resistivity significantly. Results obtained at 15 and 22 kiloamperes and pressures of 0.5, 1.0, and 5.0 torr are presented. Author (TAB)

**N69-13842*#** Columbia Union College, Takoma Park, Md. Physics Dept.
**RELATIVE SPECTRAL RESPONSE OF PHOTODETECTORS**
E. I. Mohr Oct. 1968 14 p refs
(Grant NGR-21-023-001)
(NASA-CR-98516) Avail: CFSTI CSCL 09A

This report describes the instrumentation and procedures used to determine the relative spectral response of a detector to visible and near-infrared radiation. The optical system combines a double-pass monochromator with a beam splitter (dual beam chopper). Radiation from a mercury-xenon arc or from a globar is focussed on the entrance slit of the monochromator. After the second pass through the optical system of the monochromator, the radiation is focussed on the exit slit of the monochromator, collected by the reimaging optics, and directed toward the beam splitter. The beam splitter then sends one of the two beams to the reference detector (thermocouple), and the second one to the detector which is to be calibrated. First experimental results are discussed, and improvements to increase the accuracy are suggested. Author

N69-13889# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.
**COMPACT CHAMBER FOR IMPEDANCE AND POWER TESTING OF VHF WHIP ANTENNAS Final Report, 1 Jul. 1967–1 Jul. 1968**
William R. Free, Bernard M. Jenkins, and Charles W. Stuckey Oct. 1968 111 p refs
(Contract DAAB07-67-C-0575)
(AD-676846; GIT-A-1031-F; ECOM-0575-F) Avail: CFSTI CSCL 9/5

The report summarizes the accomplishments on a program to develop a compact test chamber suitable for production testing of VHF vehicular antennas. A compact test chamber consisting of a 12 foot long aluminum cylinder, 1 foot in diameter and lined with Eccosorb NZ-1 ferrite material was developed. This chamber was calibrated with respect to open-field antenna characteristics. Results from an extensive evaluation are presented which attest to the usefulness of the chamber in meeting production and/or field test and alignment requirements. Investigations of the reflectivity characteristics of a number of absorbing materials, the effects of absorbing materials in the near-field of antennas, and the effects of ground plane size on antenna characteristics are described and results from these programs are presented. Author (TAB)

# 10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N69-12687# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**APPLICATION OF REVOLVING TRANSFORMERS AS TRANSDUCERS OF FEEDBACK OF SYSTEMS OF PROGRAM CONTROL**
V. F. Gornev et al *In its* Computer Eng., No. 5 24 Nov. 1967 p 267–282 refs (See N69-12660 03-08)
Avail: CFSTI

Circuits and their equations of revolving transducers of feedback in computerized control systems are presented with calculations of error and the effect of nonorthogonality of input voltage vectors and nonlinearity of the reference signal on the accuracy of the system. Author

N69-12731 Montana State Univ., Missoula.
**NEW TECHNIQUES IN THE ANALYSIS OF HOMOLOGOUS BINAL NETWORKS**
George Hampton Grenier (Ph.D. Thesis) 1967 209 p
Avail: Univ. Microfilms: HC $9.45/Microfilm $3.00 Order No. 67-13581

Performance criteria were defined relating to the symmetry of balanced networks and these embody a new set of balance factors involving the network's susceptibility to common-mode interference. A new list of definitions is offered in an effort to remove some of the ambiguities caused by the specialized usage of generic terms as well as applications inconsistent with presently existing professional standards. The networks under study are actually double ones and made up of two similar parts called binary parts or biparts: the two biparts comprise the binal network or binet. The concept of common-mode interference is enlarged to include paths of influx into all homologous node-pairs of a binet, to be driven through equivalent source impedances chosen to represent either the actual self impedances of an interfering wave, or variously, from worst to best case combinations of these. An indefinite admittance matrix is used to simplify analyses of the resulting test circuit configurations. Dissert. Abstr.

N69-12733 Arizona State Univ., Tempe.
**AN APPROXIMATE METHOD FOR OPTIMAL CONTROL OF DISTRIBUTED PARAMETER SYSTEMS**
Curtis Wilson Dodd (Ph.D. Thesis) 1968 85 p
Avail: Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 68-1648

The methods of spatial discretization, time-space discretization, and harmonic truncation are presented for determining the response of distributed parameter systems to initial conditions and control functions. The techniques for handling initial conditions, boundary conditions, distributed controls and cascaded lumped systems when using the spatial or time-space model is discussed. Stability criteria are presented for handling the differential and difference equations representing the partial differential equations. After a valid mathematical model of a distributed system is obtained the techniques for solving the difference and differential equations are discussed. Of special interest here is the state space solution to the ordinary differential equations used to represent the diffusion equation; a general expression for the state transition matrix is determined for arbitrary n (the order of the approximation). Dissert. Abstr.

N69-12734 Wisconsin Univ., Madison.
**APPROXIMATIONS TO THE OPTIMAL CONTROL OF LINEAR SYSTEMS SUBJECT TO STATE VARIABLE CONSTRAINTS BY USE OF LINEAR PROGRAMMING TECHNIQUES**
August Frederick Fath (Ph.D. Thesis) 1967 268 p
Avail: Univ. Microfilms: HC $12.15/Microfilm $3.45 Order No. 67-12421

The development of numerical procedures is considered to approximate the time optimal control and the fixed time fuel optimal control for linear systems subject to convex constraints on both the control vector and on the state vector. The problem formulation allows the use of convex target sets for both the time optimal problem and the fuel optimal problem and further allows the use of an allowable initial state set in the fuel optimal problem. For the time optimal control problem, the approximations of assuming the control vector to have constant components on sub-intervals and of enforcing the constraints only at discrete instants of time are used along with linear programming techniques to obtain points on the boundary of the set of states reachable from the target set by allowable trajectories on a fixed time interval. Further use of an iteration on time and of sufficient conditions developed allow the solution to the state-constrained time optimal control problem to be obtained. The fixed-time fuel-optimal control problem is solved using the approximations used in the time-optimal solution and by a reformulation and solution as a linear programming problem. Dissert. Abstr.

N69-12793 Arizona Univ., Tucson.
**COMPUTATION OF REGIONS OF CONSTRAINED STABILITY FOR NONLINEAR CONTROL SYSTEMS**
Demosthenes Peter Gelopulos (Ph.D. Thesis) 1967 138 p
Avail: Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No. 68-785

The object of this study is to revise the classical control system stability criteria and to devise methods for determining the region of stability. The revision of the stability definition is motivated by the need for increased physical relevance. Excursion stability is defined in such a way that the practical constraints on the system are incorporated into the stability measure. Computational algorithms are devised which are used to determine the region of excursion stability. Two distinct algorithms evolve which are compared on the basis of computational efficiency. The stability criterion is based on satisfaction of certain state-space constraints. The constraints are selected by considering the practical limitations of the system and the region of validity of the system model. The region of excursion

stability consists of all those disturbed system states for which the ensuring trajectory does not violate the constraints.
Dissert. Abstr.

**N69-12842** Illinois Univ., Urbana.
**SENSITIVITY REDUCTION USING OPTIMALLY DERIVED CONTROLLERS**
James Phillip Herner (Ph.D. Thesis) 1967 40 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-1767

Feedback structures which reduce the parameter sensitivity of a linear system are derived from the solution of the classical linear regulator problem. Linear, time varying systems with several inputs and outputs are treated, and simplifications in the design are noted for the time invariant case. Throughout the discussion, problems of implementation are considered as constraints on the design of the system. Specifically, unbounded elements in the controller are now allowable as the solution to the sensitivity problem. It is shown that for the structure, herein called Nth order feedback, the sensitivity of the system may be reduced to an arbitrarily small value.
Dissert. Abstr.

**N69-12847** Duke Univ., Durham, N. C.
**A FEEDBACK CONTROL SYSTEM BASED ON THE DYNAMICS OF A BOILING HEAT TRANSFER**
Alfred John Goetze (Ph.D. Thesis) 1967 154 p
Avail: Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 68-2721

A study is made of the possibility of stable operation in all three regions of the boiling curve of a boiling heat transfer process with a closed loop feedback control system that contains an electrically heated surface in the form of a 5 mil platinum wire immersed horizontally in a bath of Freon 113. An extension of an existing formulation of the dynamics of boiling heat transfer is made and applied to the system. A system transfer function is derived that relates small changes of heater surface temperature and power generated in the heater as a function of the slope of the boiling curve. Experimental results are presented verifying the system transfer function in the nucleate and film regions with the use of open loop methods. The results indicate that the transfer function concept relating incremental variations of heater temperature and generated power to the slope of the boiling curve is a very useful one for the automatic control of the heater temperature particularly in the normally unstable transition region.
Dissert. Abstr.

**N69-12896** Illinois Univ., Urbana.
**SOME GENERALIZATIONS IN SYSTEM THEORY AND THEIR APPLICATIONS TO CONTROL SYSTEMS**
Sadanand Dinkar Agashe (Ph.D. Thesis) 1967 132 p
Avail: Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 68-1697

Some definitions of the concepts state and state-deterministic system have been given by L. A. Zadeh and C. A. Desoer in their book Linear System Theory: The State Space Approach. In this thesis, using some of their ideas such as physical systems and their measurable attributes, a more fundamental definition of a system is given. Two new concepts, namely, functional dependence and quasi-functional dependence between attribute sets, are introduced, by means of which the concepts of output, input, and state, attribute sets are defined. Comparison of systems in two ways, in terms of their index sets and in terms of their attribute sets, is used to clarify the concepts of extensionally-state-determined and extensionally-state-stochastic systems.
Dissert. Abstr.

**N69-12932** Ohio State Univ., Columbus.
**AN EXTENSION OF PONTRYAGIN'S MAXIMUM PRINCIPLE**
Hsi-Han Yeh (Ph.D. Thesis) 1967 116 p
Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 68-3094

The problem of optimum control of systems whose control signals belong to a prespecified class of functions is studied. The result is formulated in a maximum principle of the Pontryagin type. The extended maximum principle states that a necessary condition for the optimum control is that the first variation of the time integral of the Hamiltonian is zero if the control function can vary in two opposite directions, is non-positive if the control function can vary in only one direction. The conditions imposed on the admissible controls are: (1) The control signals may be restricted to a prespecified class of functions which are piecewise continuous with a finite number of points of discontinuity, and which are continuous on the left at every instant under consideration. (2) The admissible class of controls admits infinitesimal variation. (3) The control signals satisfy some boundedness constraints.
Dissert. Abstr.

**N69-13178#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THEORY OF STRUCTURE AND SIGNAL FORMATION (SELECTED ARTICLES) [ SINTEZ KOMBINATORNYM METODOM NEIZBYTOCHNYKH PARALLEL'NO-POSLEDOVATEL'NYKH STRUKTUR]**
20 Oct. 1967 25 p refs Transl. into ENGLISH from AN SSSR. Inst. Avtomat. i Telemekhaniki. Tekhnol. Kibernetika. 1965 p 368–381
(AD-675921; FTD-HT-23-912-67) Avail: CFSTI CSCL 9/5

CONTENTS:

1. THE SYNTHESIS OF NONREDUNDANT SERIES-PARALLEL STRUCTURES BY THE COMBINATORIAL METHOD V. R. Gorovoy p 1–6 refs (See N69-13179 03-10)

2. THE EXPANSION OF THREE-VALUED LOGIC FUNCTIONS B. A. Kakhyugin p 7–17 refs (See N69-13180 03-19)

**N69-13179#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE SYNTHESIS OF NONREDUNDANT SERIES-PARALLEL STRUCTURES BY THE COMBINATORIAL METHOD**
V. R. Gorovoy *In its* Theory of Struct. and Signal Formation 20 Oct. 1967 p 1–6 refs (See N69-13178 03-10)
Avail: CFSTI

A specialized logic machine which fully automates the combinatory method for synthesizing type relay-contact structure, K-terminal networks, is described. The combinatory method is intended for the synthesis of contact bridge structures. The initial data for setting up these structures are functions of the input terminal, where the function is identically equal to one, and the given functions K of the output terminals, which may have the values 1, 0, ∞. The synthesis uses two basic operations $\omega_1$ and $\omega_2$. In $\omega_1$ a new unit is introduced into the circuit which is connected to one of the existing units. In $\omega_2$, two existing units are connected. At every point of the synthesis one or the other operation is performed. The results are definite changes in the function of the units in the structure. Synthesis is complete when all the values of 1 for all the functions of the output units in a circuit become 1. The possibility of obtaining small forms of Boolean functions on the machine is considered. It was shown that the combinatory method does not exclude contacts which correspond to redundant letters from the structure. It was also shown that series-parallel structures may be obtained by means of the combinatory method.
Author

**N69-13292** Technische Hochschule in Wien (Austria). Inst. fuer Niederfrequenztechnik.
**EXPERIMENTAL STOCHASTIC PROCESSES [EXPERIMENTELLE STOCHASTISCHE PROZESSE] Quarterly Report for Period Ending 31 Mar. 1967**
R. Eier and A. Grassl 31 Mar. 1967 30 p refs In GERMAN Sponsored by the Austrian Govt.
(QR-StP-1/11) Avail: CFSTI

Transfer matrices of Markov chains are used to formulate the basic principles of Markov step processes. Autocorrelation functions and performance spectra of two step processes are developed from various statistical parameters. The electronic realization of above processes is shown in block diagrams. Transl. by G.G.

**N69-13293** Technische Hochschule in Wien (Austria). Inst. fuer Niederfrequenztechnik.
**EXPERIMENTAL STOCHASTIC PROCESSES [EXPERIMENTELLE STOCHASTISCHE PROZESSE] Quarterly Report for Period Ending Jun. 1968**
P. Eier and A. Grassl 30 Jun. 1968 58 p refs In GERMAN Sponsored by the Austrian Govt.
(QR-StP-1/111) Avail: CFSTI

The importance of simple and higher order correlations in Markov step processes is demonstrated through correlation functions, correlation spectra, and correlation chains. Matrix calculations are used to develop electronic elements for r-step processes with $(2r-1)$ degrees of freedom as well as the transfer matrix and amplitude value for a Markov AK chain. Transl. by G.G.

**N69-13294** Technische Hochschule in Wien (Austria). Inst. fuer Niederfrequenztechnik.
**EXPERIMENTAL STOCHASTIC PROCESSES [EXPERIMENTELLE STOCHASTISCHE PROZESSE] Annual Report, 1967**
H. Donko, Wolfgang Wehrmann, and H. Weinrichter 31 Dec. 1967 70 p refs In GERMAN Sponsored by The Austrian Govt.
(AR-StP-11) Avail: CFSTI

Markov step processes are used to develop a new measuring method for correlation functions and to construct a relay correlator for processing signals up to 100 MHz frequencies. Transl. by G.G.

**N69-13295** Technische Hochschule in Wien (Austria). Inst. fuer Niederfrequenztechnik.
**EXPERIMENTAL STOCHASTIC PROCESSES [EXPERIMENTELLE STOCHASTISCHE PROZESSE] Quarterly Report for Period Ending 30 Sep. 1967**
H. Donko and R. Eier 30 Sep. 1967 38 p refs In GERMAN Sponsored by the Austrian Govt.
(QR-StP-3/11) Avail: CFSTI

Analyzed are allowable degrees of freedom for the transfer matrix of stationary Markov chains when the matrix is determined by eigenvalues and eigenvectors. It is shown that transfer matrices can be separated by diagonal and non-diagonal characteristics; to latter exhibit non-degenerative properties and are suitable for Markov step processes. A block diagram of an electronic circuit with evenly distributed coincidence voltage in a variable amplitude interval is included. Transl. by G.G.

**N69-13296** Technische Hochschule in Wien (Austria). Inst. fuer Niederfrequenztechnik.
**EXPERIMENTAL STOCHASTIC PROCESSES [EXPERIMENTELLE STOCHASTISCHE PROZESSE] Quarterly Report for Period Ending 30 Jun. 1967**
Wolfgang Wehrmann and A. Grassl 30 Jun. 1967 39 p refs In GERMAN Sponsored by the Austrian Govt.
(QR-StP-2/11) Avail: CFSTI

Described are the working principles of three generators for Markov step processes. The first device uses an amplitude series of higher Markov chains to rule the initial signal for more than one step interval; the second functions in four amplitude steps; and the last generator utilized time bound parameters to produce non-stationary processes. Also included are measurement problems connected with the simulation of stochastic processes. Transl. by G.G.

**N69-13496#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CALCULATION OF DYNAMIC CHARACTERISTICS OF CONTROLLED OBJECTS WITH THE HELP OF A DIGITAL CORRELOGRAPH [VYCHISLENIE DINAMICHESKIKH KHARAKTERISTIK UPRAVLYAEMYKH OBEKTOV S POMOSHCHYU DISKRETNOGO KORRELOGRAFA]**
V. V. Imedadze et al. 9 Nov. 1967 15 p refs Transl. into ENGLISH from the book "Analiticheskiye Samonastraivayushchiyesya Sistemy Avtomaticheskogo Upravleniya" 1966 p 127–135
(AD-676544; FTD-MT-67-21) Avail: CFSTI CSCL 12/1

The article deals with the use of the digital correlograph in calculating the dynamic characteristics of controlled objects. TAB

**N69-13497#** Northwestern Univ., Evanston, Ill. Information-Processing and Control Systems Lab.
**RESEARCH IN MODERN CONTROL THEORY Final Report**
G. J. Murphy Jun. 1968 12 p refs
(Grants AF-AFOSR-270-63; AF-AFOSR-270-65)
(AD-676684; AFOSR-68-1969) Avail: CFSTI CSCL 12/1

A procedure for optimal synthesis of linear pulse-width-modulated computer-controlled systems by dynamic programming and a method for time-optimal pulse-width control of linear plants were originated. A sufficient condition for asymptotic stability in the large of pulse-width-modulated feedback control systems was established also, as was a generalization of that result to obtain a sufficient condition for stability of a class of discrete feedback systems with parallel nonlinear elements. A procedure for the analysis and synthesis of a class of periodically switched linear systems was also developed, and a straight-forward procedure for the optimal design of nonlinear sampled-data control systems was originated. Interest in fundamental problems of stability led then to the establishing of a necessary and sufficient condition for asymptotic stability in the sense of Lagrange of a class of delta-modulation data-transmission systems, and finally to the creation of a new chart and a new tool for practical application of earlier theoretical results in a frequency-domain test for absolute stability of nonlinear feedback systems. Author (TAB)

**N69-13531#** State Univ. of New York, Stony Brook. Coll. of Engineering.
**APPLICATION OF GENERALIZED FUNCTION THEORY TO NETWORK REALIZABILITY THEORY AND TIME DOMAIN SYNTHESIS OF POSITIVE-REAL FUNCTIONS, PART 2 Final Report, Jun. 1, 1963–Aug. 31, 1968**
Armen H. Zemanian 31 Aug. 1968 21 p refs
(Contract AF19(628)-2981)
(AD-676785; AFCRL-68-0389; Rept-109) Avail: CFSTI CSCL 9/5

The report contains a brief summary of results under the following five categories: The time-domain significance of positive-reality; The time-domain synthesis of distributions; The distributional generalization of integral transformations; The application of generalized integral transformations to time-varying networks; and, Contributions to the realizability theory of networks. TAB

N69-13539# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SYNTHESIS OF CIRCUITS FROM THRESHOLD AND TWO-THRESHOLD ELEMENTS [SINTEZ SKHEM IZ POROGOVYKH I DVUKHPOROGOVYKH ELEMENTOV]**
Ch. I. Askerov Nov. 1967 13 p refs Transl. into ENGLISH from Probl. Peredachi Inform. (Moscow), v. 1, no. 4, 1965 p 49–54
(AD-676530; FTD-HT-23-566-67) Avail: CFSTI CSCL 9/5

Methods are set forth for synthesis of circuits from threshold and two-threshold elements for an arbitrary boolean function. The methods do not guarantee optimum (from the standpoint of the number of necessary elements) realizations, since the synthesis process is nonunique. Author (TAB)

N69-13570# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DETERMINING THE TRANSFER FUNCTION OF A DYNAMIC SYSTEM WITH CONSTANT PARAMETERS [OPREDELENIE PEREDATOCHNOI FUNKTSII DINAMICHESKOI SISTEMY S POSTOYANNYMI PARAMETRAMI]**
B. B. Sodell Aug. 1967 14 p refs Transl. into ENGLISH from Avtomat. Vychisl. Tekh. (USSR), no. 9, 1965 p 49–58
(AD-676569; FTD-HT-23-955-67) Avail: CFSTI CSCL 12/1

It is shown how the method for determining the transfer function of a dynamic system with constant parameters developed by A. N. Sklyarevich (Sklyarevich, A. N. Operatornyye metody v statisticheskoy dinamike avtomaticheskikh sistem. Nauka, M., 1965) can be extended to the case when the poles of the transfer function of the system and the Laplace transform of the correlation function of the input signal do not coincide and are of order higher than one. A procedure for determining the cross-correlation function of the input and output signals is presented. This cross-correlation function is used as a basis for deriving a system of algebraic equations for determining the coefficients of the frequency response function and a recurrence formula for their calculation is presented. It is stressed that the results obtained here can be utilized in designing a special-purpose computer for calculating the transfer functions. Two examples illustrate the calculation procedure. TAB

N69-13678# Pennsylvania Research Associates, Inc., Philadelphia.
**SELF-REPAIR THEORY INVESTIGATION Quarterly Report, 1 Jul.–30 Sep. 1967**
Edward W. Veitch May 1968 30 p refs
(Contract DA-28-043-AMC-02344(E))
(AD-676843; ECOM-02344-5; QR-5) Avail: CFSTI CSCL 9/5

This is the fifth report from a study to develop a theory of self-repair in digital nets via fault diagnosis and automatic circuit replacement using the sequential prime implicant form for net representation as an analytical tool for specifying the monitoring circuitry. This report discusses problems associated with optional use of the replacement and check circuitry. Author (TAB)

N69-13703# Pennsylvania Research Associates, Inc., Philadelphia.
**SELF-REPAIR THEORY INVESTIGATION Quarterly Report, 1 Oct.–31 Dec. 1967**
Edward W. Veitch and David C. Roberts May 1968 44 p refs
(Contract DA-28-043-AMC-02344(E))
(AD-676844; ECOM-02344-6; QR-6) Avail: CFSTI CSCL 9/5

This is the sixth report from a study to develop a theory of self-repair in digital nets via fault diagnosis and automatic circuit replacement using the Sequential Prime Implicant Form for net representation as an analytical tool in net failure detection and diagnosis. This report discusses the computer program being developed to implement the SPIF algorithms. It also discusses the problem of self-repair without loss of data. Author (TAB)

N69-13705*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
**APPLICATION OF OPTIMAL CONTROL THEORY TO LAUNCH VEHICLES COMPUTER PROGRAM DOCUMENTATION**
M. D. Ward [1968] 65 p refs
(Contract NAS8-21063)
(NASA-CR-98153; HONEYWELL-12073-FR-2) Avail: CFSTI CSCL 09B

This report presents the digital computer optimization program developed in conjunction with an investigation of the application of optimal control theory to the design of launch vehicle control systems. The individual subprograms that make up the optimization program are described. The attendant equations which are presented result from the solution of the difference equation formulation of the quadratic control problem and the derived analytical expression for the upper bound on the likelihood of occurrence of mission failure. The input requirements for two types of computer runs are described. The expected output for the optimization iteration run and the simplification run are displayed and identified through the use of actual output listings. Memory requirements, program modifications due to memory requirements, and the expected running time for the optimization programs are discussed. The appendices contain flow charts for the entire program, information on data storage and a glossary relating mathematical notation to FORTRAN notation. Author

N69-13711# Pennsylvania Research Associates, Inc., Philadelphia.
**SELF-REPAIR THEORY INVESTIGATIONS Quarterly Report, 1 Apr.–30 Jun. 1967**
Edward W. Veitch May 1968 45 p refs
(Contract DA-28-043-AMC-02344(E))
(AD-676855; ECOM-02344-4; QR-4) Avail: CFSTI CSCL 9/5

This is the fourth report from a study to develop a theory of self-repair in digital networks via fault diagnosis and automatic circuit replacement. This report goes into further detail concerning one particular self-repair algorithm that has resulted from the study, and applies this algorithm to several examples of digital networks. Author (TAB)

# 11 FACILITIES, RESEARCH AND SUPPORT

**Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.**

N69-12755# Joint Publications Research Service, Washington, D. C.
**MAGNETIC SURFACE DISTORTION IN THE STELLARATOR S-1**
F. V. Karmanov et al *In its* Res. in Tech. Phys. 26 Nov. 1968 p 43–45 refs (See N69-12751 03-25)
Avail: SOD/CFSTI

When studying the magnetic field of the S-1 stellarator, it was discovered that the magnetic surfaces are appreciably distorted. The deformations are manifested in the form of blips running from the separatrix to the vacuum chamber wall. The deformations increase with an increase in the ratio of $h_3/H_0$. Author

N69-12757# Joint Publications Research Service, Washington, D. C.
**ACCELERATING FIELD OF A LINEAR INDUCTION ACCELERATOR**
Yu. P. Bakhrushin et al *In its* Res. in Tech. Phys. 26 Nov. 1968 p 58-70 refs (See N69-12751 03-25)
Avail: SOD/CFSTI

A mathematical discussion is presented on the value of the accelerating field at various points of an axially symmetrical system. Expressions defining the value and equations for determining the intensity of the field at the various points are presented, followed by a consideration of the boundary conditions which affect the solution. A.C.R.

N69-12869# Georgia Inst. of Tech., Atlanta. Office of Radiological Safety.
**USE OF THROW AWAY CARTRIDGES TO CONTAIN TRITIUM RELEASED IN NEUTRON GENERATORS**
Robert L. Zimmerman, Robert M. Boyd, John R. Wright, and Martin W. Mitchell Apr. 1968 6 p refs Presented at the Conf. on Small Accelerators, Oak Ridge, Tenn.
(Contract AT(40-1)-1346)
(ORO-3346-29; CONF-680411-3) Avail: CFSTI

The use of a throw-away molecular sieve cartridge in the vacuum line between the ion pump and the roughing pump for concentrating the tritium which is freed for neutron generator targets is described. In addition to reducing tritium contamination resulting from the operation, this device improves the generator output by adsorbing contaminants which degrade the desired low vacuum characteristics. NSA

N69-12885# Los Alamos Scientific Lab., N. Mex.
**MEDIUM-ENERGY PHYSICS PROGRAM Quarterly Status Report, Period Ending 31 Jul. 1968**
29 Aug. 1968 41 p refs
(Contract W-7405-Eng-36)
(LA-3988-MS) Avail: CFSTI

Recent developments at LAMPF are discussed including developments in accelerator structures, RF power systems, accelerator control and instrumentation, accelerator physics, and the experimental area. NSA

N69-12925# Rensselaer Polytechnic Inst., Troy, N. Y.
**LINEAR ACCELERATOR PROJECT Progress Report, 1 Apr.–30 Jun. 1968**
30 Jun. 1968 100 p refs
(Contract AT(30-3)-328)
(RPI-328-133) Avail: CFSTI

The energy variation of $\nu$ for $^{239}Pu$ was measured in 4 over-lapping energy ranges from 0.01 eV to 10 keV; spin assignments for resonances of 22 to 100 eV were made. A series of position-dependent fast neutron spectrum measurements in rectangular assemblies of Fe and depleted U was performed; comparisons were made with theoretical predictions. Data were obtained on neutron inelastic scattering by water at the following temperatures and neutron energies: 27°C and 0.040, 0.154, 0.332 eV; 170°C and 0.040, 0.154 eV; 270°C and 0.632 eV. Progress in development of methods for calculating the space, energy, and time variations of the flux in a reactor is summarized. The $^{238}U$ temperature coefficient was calculated using Doppler-broadened p-wave neutron cross sections, and time-dependent thermal neutron spectra and time moments for H $O_2$ NSA

N69-12981# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy.
**WIRE SPARK CHAMBER WITH STATIC MAGNETOSTRICTIVE DELAY-LINE STORE**
T. V. Bespalova, I. A. Golutvin, Yu. V. Zanevskii, Yu. T. Kiryushin, V. D. Kondrashov et al 1968 9 p refs In RUSSIAN
(JINR-P13-4020) Avail: CFSTI

A filmless wire spark chamber with static magnetostrictive delay line store is described. The application of this chamber simplifies an information pick up and essentially reduces the necessary volume of registration apparatus. The efficiency of coordinate detection in the chamber with static store is no poorer than that in the usual magnetostrictive and ferrite chamber, and the accuracy of coordinate measurement is better. Author (NSA)

N69-13145*# Reilly Translations, Los Angeles, Calif.
**LUNAR STATION TELEVISION CAMERA**
A. S. Selivanov et al 1968 13 p refs Transl. into ENGLISH from Tekhn. Kino i Televideniya (Moscow), no. 1, Jan. 1968 p 9–17 Prepared for JPL
(Contract NAS7-100)
(NASA-CR-97084) Avail: CFSTI CSCL 22A

The design and operation of panoramic TV cameras aboard the Luna 9 and 13 automatic lunar stations is described. Conditions of image transmission, parameters of the scanning device, signal shaping, and automatic sensitivity control techniques were included, as well as the geometric construction of the camera itself. The performance of the cameras confirmed the validity of the original design and enabled transmission of stereoscopic images of lunar surface formations. A.C.R.

N69-13165# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.
**INVESTIGATION OF POSSIBLE APPLICATION OF THE MAGNETRON TYPE ION SOURCE IN THE ON-LINE ELECTROMAGNETIC SEPARATOR**
A. V. Dem'yanov et al 1968 20 p refs In RUSSIAN
(JINR-P13-3953) Avail: CFSTI

The results of the experiments with the gas-discharging ion source of a magnetron type which operates in a regime near that of the electromagnetic separator on-line with the cyclotron, are presented. The problems of the ionization efficiency, the ion beam focusing, and optimal dimensions of an ion source construction for the ultra-small quantities of radioactive atoms are investigated. The work was performed in connection with the construction of the electromagnetic separator on-line with the heavy-ion cyclotron in the LNR of the JINR. Author (NSA)

N69-13204# United Kingdom Atomic Energy Authority, Culham (England).
**EMERGENCE OF A HYDROGEN JET FROM A SUPERSONIC NOZZLE INTO A VACUUM**
G. I. Dimov Mar. 1968 14 p refs Transl. into ENGLISH from Russian rept.
(NP-tr-1669) Avail: CFSTI

For the injection of charge-exchange protons into an accelerator, the charge-exchange target in the orbit of the accelerator is formed by a supersonic hydrogen jet operating for the duration of the injection pulse between 100 and 1000 $\mu$ sec. The design and operation of the system for obtaining a supersonic hydrogen jet are described. NSA

N69-13213*# Chrysler Corp., Huntsville, Ala. Aero-Space Mechanics Branch.
**EVALUATION OF THE ACOUSTIC SOURCES OF BACKGROUND NOISE IN WIND TUNNEL FACILITIES**
5 Jun. 1968 74 p refs
(Contract NAS8-20336)
(NASA-CR-98155; HSM-R65-68) Avail: CFSTI CSCL 14B

Methods have been developed for the evaluation of acoustic sources of background noise in wind tunnels. Existing acoustic

calibration data obtained in the AEDC 16 ft transonic wind tunnel are reviewed. The apparent sources of acoustic background noise in the tunnel are suggested. The various sources of acoustic background noise are reviewed and itemized. A method to eliminate the acoustic background noise from dynamic test data is presented. Wind tunnel acoustic calibration devices are reviewed, and the most satisfactory devices are selected for wind tunnel acoustic calibrations. The selected calibration devices have been designed. Test procedures and an acoustic calibration plan for the MSFC 14 in. trisonic wind tunnel are presented. Author

**N69-13228#** Bonn Univ. (West Germany). Institut fuer Strahlen und Kernphysik.
**ANNUAL REPORT, 1968 [JAHRESBERICHT 1968]**
May 1968 123 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-68-22) Avail: CFSTI

Information about the isochronous cyclotron under construction and the scientific work in the field of nuclear spectroscopy is given. Author (NSA)

**N69-13233** European Organization for Nuclear Research, Geneva (Switzerland). Rings Div.
**FAST CHANGING OF RF PHASE IN A LINEAR ACCELERATOR**
P. Bramham 15 Oct. 1968 46 p refs
(CERN-68-36) Avail: Issuing Activity

Beam loading in a linear accelerator cavity may be compensated by an increase in RF input power at the start of beam passage. If one amplifier chain is used both to fill the cavity and to supply beam power, the phase of the RF must be changed quickly. The various types of electronic phase shifters are discussed, and two types, one switched and the other continuous, are considered in detail. Measurements on models are described, and performance limits predicted. Author

**N69-13267#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
**AMPLITUDE SPECTRA OF RADIAL AND AXIAL BETATRON OSCILLATIONS IN THE JINR SYNCHROCYCLOTRON**
V. I. Danilov, I. B. Enchevich, E. A. Polferov, E. I. Rozanov, and A. N. Safonov 1968 25 p refs In RUSSIAN
(JINR-P9-3968) Avail: CFSTI

Methods are described for determining the amplitude spectra of radial and axial betatron oscillations of the beam particles in the synchrocyclotron. After calculations, made for the 680-MeV synchrocyclotron, the value of the maximum amplitude of the betatron radial oscillations in the final radius was found to be 15 cm and the axial oscillations 2 cm. The spectrum of the vertical oscillations is close to the Gaussian distribution. In the spectrum of the radial oscillations, amplitudes below average prevail. Author (NSA)

**N69-13312#** Oak Ridge National Lab., Tenn.
**NEUTRON TRANSMISSION IN THE ACCESS TUNNELS TO A HIGH-ENERGY PROTON ACCELERATOR**
Christian Devillers et al [1968] 34 p refs Transl. into ENGLISH from CEA rept. CEA-R-3491
(ORNL-tr-1069) Avail: CFSTI

The tridimensional monoenergetic Monte-Carlo code ZEUS has been used in order to fit the results of measurements of absorbed dose made in the access tunnels of the CERN 28 GeV proton synchrotron. Reemission of neutrons by walls was represented by albedo of absorbed dose. The experimental results are corresponding to the results of calculations done for neutrons in the energy interval 0.75 to 4 MeV. Author (NSA)

**N69-13327#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ON THE EFFECTIVENESS OF ENRICHING AIR WITH OXYGEN IN INSTALLATIONS WITH MHD GENERATORS [OB EFFEKTIVNOSTI OBOGASHCHENIYA VOZDUKHA KISLORODOM V USTANOVKAKH S MGD GENERATORS]**
G. I. Rossiyevskiy et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 142–154 refs (See N69-13314 03-03)
(SM-74/201) Avail: CFSTI

In open cycle MHD generators using ordinary air for the combustion of fuel, the increase in the initial parameters of the cycle (deceleration temperature of the combustion products before entering the channel $t_{01}$) is limited by the possibility of regenerative heating of the air by the combustion products. For natural gas the limiting value of $t_{01}$ is about 2700° C with the necessary air preheating temperature of 2000° C. At the same time the construction of a high temperature combustion products-air heat exchanger presents one of the main difficulties in achieving installations with open cycle MHD generators. The use of oxygen enriched air in MHD equipment would permit the solution of two problems: first, equipment with a moderate temperature of oxidant preheating would be achieved, and second, the initial temperatures of the cycle would be higher than with the use of ordinary air. Author

**N69-13371#** Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
**AN AGAR AGAR CHAMBER FOR THE STUDY OF ELECTROMAGNETIC WAVES IN AN INHOMOGENEOUS MEDIUM**
Keigo Iizuka Jun. 1968 127 p refs
(Contract N00014-67-A-0298)
(AD-676914; TR-565) Avail: CFSTI CSCL 20/14

A medium for the propagation of electromagnetic waves whose dielectric constant or loss tangent has a prescribed profile was fabricated by using a large quantity of agar agar in simulation chambers. The dielectric constant of the agar agar could be changed continuously by means of a controlled diffusion of ethyl alcohol. The loss tangent of the same medium could be changed continuously by means of a controlled diffusion of sodium chloride. This is the first of a series of reports. It is concerned with the design and characteristics of the simulation chamber. Measured results obtained with the chamber are described in later reports. Topics to be considered include the properties of agar agar in a wide frequency spectrum, the diffusion constant of NaCl in agar agar, the diffusion profiles, a re-examination of the principle of simulation, the construction of various types of probes and simulation chambers. Author (TAB)

**N69-13373#** Ministry of Technology, London (England).
**THE ADVANTAGES AND LIMITATIONS OF COMMONLY USED METHODS OF NON-DESTRUCTIVE TESTING**
Sep. 1968 20 p
(S&T-MEMO-9/68) Avail: CFSTI

Assesses the state-of-the-art in six commonly used methods and highlights their shortcomings as well as their field of useful application. The methods are: 1) Magnetic particle inspection, 2) Penetrant inspection, 3) Ultrasonic testing, 4) X-and gamma radiography, 5) Fluoroscopy, and 6) Eddy-current testing. Some suggestions are made in each case concerning unsolved problems on which further fundamental investigation work is required. Author (ESRO)

**N69-13413#** College of Aeronautics, Cranfield (England).
**THE DEVELOPMENT AT CRANFIELD OF A FREE PISTON COMPRESSION TUBE**

M. J. Pratt London HMSO Feb. 1967 21 p refs Supersedes COA-AERO-194; ARC-29360; see N67-36038
(ARC-CP-1002; COA-AERO-194; ARC-29360) Avail: CFSTI

The free piston compression shock tube provides a simple means of obtaining shock Mach numbers of the order of 30. This paper concerns the design and development at Cranfield of such a shock tube. The problems encountered in evolving a piston capable of withstanding heavy impacts at the completion of its stroke are outlined, and some preliminary shock tube performance data given. Author (ESRO)

N68-13525# National Physical Lab., Teddington (England). Aerodynamics Div.
SIMPLE WIND TUNNEL DESIGN
P. Bradshaw Mar. 1968 26 p refs
(NPL-AERO-1258) Avail: CFSTI

This note is intended for workers in industry and teaching establishments who wish to design simple wind tunnels for demonstration purposes, student use or tests of non-flying objects. The emphasis is on simplicity and low cost rather than high quality of air flow, although there is no reason why low turbulence intensity and good mean flow uniformity should not be obtained in a small cheap tunnel. Author (ESRO)

N68-13782# Naval Research Lab., Washington, D. C.
LINAC OPERATION Memorandum Report, 1 Jan.-30 Jun. 1968
Jul. 1968 23 p refs
(AD-676504; NRL-MR-1909) Avail: CFSTI CSCL 20/7

The operation and use of the NRL 60 MeV Electron Linear Accelerator is described for the period 1 January - 30 June 1968. Progress reports on the Linac Branch experiments are included, covering electron scattering at 180 deg, two photonuclear experiments, and preliminary neutron capture time-of-flight measurements. Total user time decreased to 1058 hours due to two vacuum accidents, each of which partially destroyed an electron gun. The downtime was used for various engineering improvements, including new rf loads, a rebuilt master timer, and installation of an improved waveguide cooling system. Non-Linac Branch users from eight groups received 32% of the available time, and are individually summarized. Author (TAB)

N68-13871*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DEVELOPMENT OF AN ISOTROPIC RADIATION SIMULATOR
Lester Katz 11 Sep. 1968 20 p
(NASA-TM-X-53780) Avail: CFSTI CSCL 14B

Films for spacecraft use, which are sensitive to isotropic background radiation, are usually tested by exposure to high-energy particles emanating from an accelerator. Since the particles move in essentially parallel paths, the film is not irradiated in an isotropic mode. Laboratory use of the device described in this report furnishes a method to expose emulsions and other radiation-sensitive items to an isotropic distribution of radiation that is limited to half-space exposure. Author

# 12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N69-12803 Stanford Univ., Calif.
THE INFLUENCE OF ROTATION OF FLOW IN A LONG RECTANGULAR CHANNEL: AN EXPERIMENTAL STUDY
Robert Marvin Hallsen (Ph.D. Thesis) 1967 193 p
Avail: Univ. Microfilms: HC $9.80/Microfilm $3.00 Order No. 67-17432

An investigation is reported of the flow regimes and structures in flow through a rectangular channel rotating about an axis perpendicular to the relative velocity vector of the flow and the narrow wall of the channel. Flow regimes for the wall layers of the leading and trailing surfaces as a function of the Reynolds number and a nondimensional rotational parameter, $N_{Ro}$, are delineated. Flow regime data were obtained primarily from wall-slot dye injection and photography. Mean velocity profiles, wall shear, and reduced pressures across the channel are also given. For no rotation, the flow at the test section had a fully developed turbulent mean velocity profile for all cases investigated. In this nonrotating flow, the observed features of the wall layers on both walls were the same and agreed with comparable measurements from turbulent boundary layers due to others. As the speed of rotation (and hence the rotation parameter) is increased, important changes in the wall layer structures, shear, and mean velocity profiles are observed on both walls. Dissert. Abstr.

N69-12807 Clemson Coll., S. C.
ANALYTICAL AND EXPERIMENTAL STUDY OF THE PULSEJET EJECTOR
William Stanley Johnson (Ph.D. Thesis) 1967 132 p
Avail: Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 68-1662

This study was undertaken to investigate the pulsejet ejector by both analytical and experimental means in order to evaluate the effectiveness of the mechanism of energy exchange from the primary to the secondary fluid. Preliminary investigations have indicated that this mechanism is quite unlike that of the steady flow ejector, and offers a distinct potential of higher efficiency by replacing a mixing process by a wave motion process. Also included in the study was the establishment of the performance (ratio of secondary to primary flow) of the pulsejet ejector as a function of its pertinent parameters, and the formulation of an analytical procedure to predict the performance accurately. Good agreement was obtained between the analytical predictions and the experimental measurements so that the proposed mathematical model and the resulting numerical solution procedure were judged adequate to make further performance predictions. Dissert. Abstr.

N69-12810 Colorado State Univ., Fort Collins
DIFFUSION FROM AN INSTANTANEOUS POINT SOURCE INTO A TURBULENT BOUNDARY LAYER
Suresh Chandra (Ph.D. Thesis) 1967 155 p
Avail: Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 68-2586

Diffusion of helium gas from an instantaneous point source within a neutral boundary layer has been studied. The investigation was made in a wind tunnel. Concentrations from a simulated point source, located at a fixed height of eight inches above a smooth surface, were measured for several downstream cross-sections of the diffusing cloud. The free stream velocity for the entire study was 20 ft./sec. Statistical parameters have been used to describe the concentration data in terms of the time-average as well as the maximum instantaneous concentration at a point in the diffusion field. The lateral and vertical diffusivities are determined from the diffusion data. Comparison of data from the instantaneous point source, in terms of the time-averaged concentration parameters, with the continuous point source data of other investigators shows good agreement. The concentration data are presented in terms of dimensionless parameters. Dissert. Abstr.

N69-12611 California Inst. of Tech., Pasadena.
**MAGNETOFLUID-DYNAMIC DRAG MEASUREMENTS ON SEMI-INFINITE BODIES IN ALIGNED FIELDS**
Bob Hiro Suzuki (Ph.D. Thesis) 1967 116 p
Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 68-1671

Experiments are described in which measurements were made of the drag of semi-infinite bodies moving parallel to a uniform magnetic fluid in a conducting fluid. Two of these bodies were moderately streamlined halfbodies and a third was a blunt halfbody. The drag coefficients of all three bodies were found to increase monotonically as a function of the interaction parameter, N. Although the drag could not be calculated for large, finite values of N, an inviscid theoretical model of the flow is described from which it is concluded that the drag coefficient of any halfbody must approach unity as $N \to \infty$. In addition to the experiments with the semi-infinite bodies, experiments are also described in which measurements were made of the non-magnetic drag of impulsively-started flat disks. Some unexpected and interesting transient variations in this drag were observed and are attributed to the vortex formation process in the wake. Dissert. Abstr.

N69-12624 California Univ., Berkeley.
**SUPERSONIC SEPARATED FLOW DOWNSTREAM OF A BACKWARD FACING STEP**
Donald Robert Crawford (Ph.D. Thesis) 1967 89 p
Avail: Univ. Microfilms: HC $4.60/Microfilm $3.00 Order No. 68-51

The method of integral relations is applied to the study of the viscous separated flow field downstream of a backward facing step in laminar supersonic flow. The boundary layer equations are reduced to a set of coupled ordinary differential equations in a formulation which incorporates a two parameter velocity profile. The neighborhood of the corner and the reattachment point are examined in detail, taking into account the proper interaction between the viscous and inviscid flow. The complete flow field in these regions is found from the analyses of the limiting forms of the equations. In particular, it is found that the pressure gradient and thickness of the boundary layer at the reattachment point are related and cannot be arbitrarily specified. Dissert. Abstr.

N69-12649 Princeton Univ., N. J.
**ON THE CALCULATION OF COMPRESSIBLE TURBULENT BOUNDARY LAYERS**
Hugh James Herring (Ph.D. Thesis) 1967 111 p
Avail: Univ. Microfilms: HC $5.60/Microfilm $3.00 Order No. 68-2485

The essential unknown quantity in a compressible turbulent boundary layer is shown to be the kinematic Reynolds stress, as in incompressible flow, and does not explicitly involve density fluctuations. Based on this, the incompressible turbulent viscosity proposed by Mellor is extended to include compressible flows. The same values of the three empirical constants, which were obtained solely from constant property, constant pressure experiments, are also used. Without making any further assumptions beyond those which yield the most general boundary layer equations, this system of equations has been programmed for numerical solution. The solutions obtained predict the velocity profile and heat transfer data well, indicating that the extension of the turbulent viscosity hypothesis to compressible flows is valid. Some error is apparent in the calculation of the flows with pressure gradients and longitudinal wall curvature. Dissert. Abstr.

N69-12690 Connecticut Univ., Storrs.
**HYDROELASTIC OSCILLATIONS OF A LIQUID SURFACE IN AN ANNULAR CYLINDRICAL TANK WITH FLEXIBLE BOTTOM**
Tien-Yu Tsui (Ph.D. Thesis) 1967 54 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-1416

The problem of coupled oscillations of a liquid with a free surface in an annular circular cylindrical tank is studied. The walls of the tank are assumed to be rigid and the bottom of the tank is considered as an elastic membrane or a thin elastic plate in bending. In the analysis, the liquid is assumed to be inviscid and incompressible and the motions are restricted to be small. Both the axisymmetric and asymmetric oscillations are investigated when the bottom of the tank is a membrane; only the axisymmetric motions are analyzed when the bottom of the tank is a thin elastic plate. The equations of the coupled natural frequencies are obtained which are shown to reduce readily to the various limiting cases. The equations for establishing the waveheights of the free surface of the liquid and mode shapes of the membrane or elastic plate are also obtained. Dissert. Abstr.

N69-12741 Rensselaer Polytechnic Inst., Troy, N. Y.
**AN ANALYTICAL STUDY OF HYPERSONIC VISCOUS FLOW OVER AN UNYAWED SLENDER CONE AT MODERATELY LOW DENSITIES**
David Freeman Rogers (Ph.D. Thesis) 1967 221 p
Avail: Univ. Microfilms: HC $10.15/Microfilm $3.00 Order No. 68-842

The interaction between the shock wave and the boundary layer is considered in the context of the hypersonic strong interaction approximation. The effects of small transverse curvature and small velocity slip and temperature jump at the wall are considered as perturbations on the basic strong interaction solution. The governing two-point boundary value problem are solved by reduction of the governing partial differential equations to a system of ordinary differential equations by means of double asymptotic expansions in terms of a slip parameter and a hypersonic transverse curvature parameter. Solutions are obtained for several values of wall-to-stagnation temperature ratio. The results show that, as expected from previous analyses, the effect of the self-induced pressure gradient is to increase the skin friction and heat transfer rate at the wall. Dissert. Abstr.

N69-12759 Kansas Univ., Lawrence.
**THE MATHEMATICAL CALCULATION OF THE DYNAMIC BEHAVIOR OF A THREE DIMENSIONAL ATMOSPHERIC CONVECTION CELL BY FINITE DIFFERENCE TECHNIQUES**
James Gregory McCreary (Ph.D. Thesis) 1967 206 p
Avail: Univ. Microfilms: HC $9.45/Microfilm $3.00 Order No. 68-606

A small volume of viscous, compressible fluid which may be considered as a region of the atmosphere, limited in volume and relatively uninfluenced by the surrounding atmosphere, is studied. The fluid is considered an ideal gas, initially at rest, with an initial vertical temperature gradient. The temperature gradient may introduce unstable vertical conditions due to the varying density of the fluid. The three dimensional isentropic flow occurs only if the flow is reversible and there is no transfer of thermal energy either between adjacent particles of fluid or from the surroundings to the fluid. Full hydrodynamic equations in three dimensions are used with the only major limiting assumption being that the single body force present is gravity. The Coriolis force is neglected. The equations are solved by finite difference techniques which are discussed in terms of stability and convergence. A computer program is presented using this procedure to predict flow patterns as a function of time. Dissert. Abstr.

N69-12760 Minnesota Univ., Minneapolis.
**STUDIES OF THE MOLECULAR THEORIES OF TRANSPORT PROCESSES IN DENSE FLUIDS**

Ching Cheng Wei (Ph.D. Thesis) 1967 199 p
Avail: Univ. Microfilms: HC $9.00/Microfilm $3.00 Order No. 68-1576

The Rice–Allnatt kinetic theory of simple dense fluids is modified, and extended to binary mixtures. The singlet and the doublet kinetic equations of the modified theory are solved, and transport coefficients of fluid mixtures, are obtained. The predictions of the modified theory are compared with those of the original RA theory and the experimental results. The H-theorem is proved for the modified singlet kinetic equations and the solubility of these equations is also shown. The time-correlation function method of transport coefficients is investigated, and an approximation formula based on a series expansion in time of the time-correlation function is proposed for the calculation of transport coefficients. An Archimedian densitometer is designed for the measurement of the density of high temperature liquids, such as molten salts, molten metals, and their mixtures. In the dilute solution of Ca in $SrCl_2$, the density of the mixture shows a positive deviation from the additive mixing. Dissert. Abstr.

**N69-12761** Princeton Univ., N. J.
**TURBULENT LIQUID MIXING, ASSOCIATED SCALAR SPECTRA AND LIGHT SCATTERING MEASURE**
David Ernest Christiansen (Ph.D. Thesis) 1967 108 p
Avail: Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 68-2466

Mixing of two miscible liquids in turbulent flow is studied using laser-generated light as the discriminating tool. Time-averaged light scatter measurements give directly a spectrum for spatial variations in tracer concentration. The measured dependence of this spectrum upon the decay time during which tracer is dissipated serves to characterize the mixing process. Spectral shape is found to undergo striking transitions with increasing decay time; beginning as a monotonic function of wave-number, the spectrum develops a single pronounced minimum and maximum. The minimum develops at the estimated Kolmogoroff microscale, the stated maximum in the viscous subrange. Results are suggestive of theoretical predictions of Beek and Miller. The spectrum, integrated over the experimental wave-number range, decreases with time of decay to the $-5/2$ power with a mixing half life of 0.98 milliseconds. Dissert. Abstr.

**N69-12836#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**[BOUNDARY LAYER RESEARCH]**
17 Nov. 1967 27 p refs Transl. into ENGLISH from Sb. Rabot. Vychislitel'nyy Tsentr., Moscow Universitet, (Moscow), no. 2, 1963 p 110–116; 135–145
(AD-675576; FTD-MT-66-170) Avail: CFSTI CSCL 20/4

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**N69-12837#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**STANDARD PROGRAM FOR THE SOLUTION OF BOUNDARY LAYER PROBLEMS [STANDARTNAYA PROGRAMMA DLYA RESHENIYA ZADACH POGRANICHNOGO SLOXA]**
V. M. Paskonov *In its* Boundary Layer Research 17 Nov. 1967 p 1–7 refs (See N69-12836 03-12)
Avail: CFSTI

The article illustrates a standard computer program evolved for the Strela computer in operation at Moscow State University. The program allows integration of the entire system of equations describing the flow of a viscous compressible gas in a boundary layer when all functions to be determined depend on two spatial co-ordinates x and y, for all possible boundary conditions, various coefficients $a_i$, $b_i$, $c_i$, $d_i$, $e_i$ and various relationships between the density $\rho$ and the functions to be determined or their derivatives. The program was also patterned to allow the development of some difference schemes for solving problems relating to an unstable boundary layer. Calculation of the variables in relation to various practical problems is carried out by means of individual subroutines, realized in terms of simple arithmetical operators. Author

**N69-12838#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**BOUNDARY LAYER IN VICINITY OF THE STAGNATION POINT [POGRANICHNYY SLOY V OKRESTNOSTI KRITICHESKOY TOCHKI]**
T. S. Varzhanskaya et al. *In its* Boundary Layer Research 17 Nov. 1967 p 9–18 refs (See N69-12836 03-12)
Avail: CFSTI

An analytical investigation is presented of a compressible laminar air boundary layer near the stagnation point of a flat porous plate through which hydrogen is uniformly injected. A system of partial differential equations in dimensionless variables describing the boundary layer and taking diffusion into account is presented and analyzed. The physical parameters of the boundary layer are assumed to be dependent on mixture concentration c and temperature. The system of partial differential equations is reduced through Dorodnitsyn's and similarity transformations to a system of nonlinear ordinary differential equations, and Dorodnitsyn's iteration method is given for their solution. A numerical computation has been made for various values of concentration at the plate surface $C_w$ =0, 0.2, 0.4, 0.6, 0.8, and 0.9. The analysis of the results shows that for $C_w$ =0 the velocity inside the boundary layer is smaller than the velocity outside the layer while at all $C_w$ >0 the velocity inside the boundary layer is greater than that outside the layer, and that the maximum of f' increases with concentration of the mixture at the plate. Author

**N69-12913** Stanford Univ., Calif.
**SCATTERING OF SURFACE WAVES BY SUBMERGED CIRCULAR CYLINDERS**
Jon Theodore Schnute (Ph.D. Thesis) 1967 143 p
Avail: Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 67-17499

This dissertation concerns itself with time-periodic and small amplitude surface wave motions on an inviscid and incompressible fluid with negligible surface tension in which parallel circular-cylinders are immersed. In Part 1 attention is given to the setting wherein a straight-crested primary wave train advances in a direction normal to the axes of a pair of cylinders and, in particular, to the characterization of the amplitudes and phases of the reflected and transmitted wave trains. Part 2 deals with progressive surface wave motions in an ideal fluid which contains an infinite array of identical submerged cylinders. Their characterization is sought in the framework of a homogeneous linear boundary value problem for harmonic functions which exhibit a common phase shift for any displacement along the direction of wave propagation with a magnitude equal to the separation between adjacent cylinders. Dissert. Abstr.

**N69-12978** California Inst. of Tech., Pasadena.
**LAMINER FLOW OF DILUTE POLYMER SOLUTIONS AROUND CIRCULAR CYLINDERS**
David Fielding James (Ph.D. Thesis) 1967 161 p
Avail: Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 67-17088

Experimental results are presented for heat transfer by free and forced convection at low velocities from small heated cylinders in dilute solutions of polyethylene oxide in water. The experiments were conducted for a range of velocities (less than 1.0 ft/sec) and polymer concentrations, with several cylinder diameters, and for several polymer molecular weights. Experimental results are also presented for the drag of a small cylinder in similar liquids and for a comparable range of velocities. The heat transfer and drag results at low velocities were identical to those for a Newtonian liquid; at high velocities, the measured values departed considerably from Newtonian results. These departures result from the viscoelastic nature of the polymer solutions. Visualization studies of the flow around a cylinder and of a minute laminar jet were conducted to determine the gross magnitude of the viscoelastic effects.
Dissert. Abstr.

**N69-12977** California Univ., Berkeley.
**THE EFFECT OF FLOW AND TEMPERATURE ASYMMETRY ON BUBBLE DYNAMICS**
Christopher Paul Witze (Ph.D. Thesis) 1967 227 p
Avail: Univ. Microfilms: HC $10.35/Microfilm $3.00 Order No. 68-184

An analytical study was performed to investigate the dynamics of vapor bubbles growing at a solid wall in a non-uniformly superheated liquid. A heat transfer controlled (asymptotic) model was assumed in all cases, but bubble geometries were allowed to vary widely so as to fully ascertain the effects of flow and temperature asymmetry. Spherical bubble growth in a uniformly superheated media and hemispherical bubble growth at a wall in a non-uniform temperature field were investigated first. It was found that the current literature on asymptotic bubble growth includes some rather restrictive assumptions concerning the bubble interior and the thermal history of the heating surface. Comparison with experimental data shows that all the bubble geometries studied generally underestimate the maximum volume achieved by subcooled boiling bubbles by a factor of five or more.
Dissert. Abstr.

**N69-12979** Michigan Univ., Ann Arbor.
**THE DYNAMICS OF GAS BUBBLES MOVING IN LIQUIDS WITH PRESSURE GRADIENT**
Hsu-Chieh Yeh (Ph.D. Thesis) 1967 142 p
Avail: Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 67-17864

The time history of the velocity, size and deformation of a gas bubble moving in the flow field around a point source or sink is studied analytically. Also included in the analysis is the dynamic behavior of a bubble moving in a quiescent liquid subject to a step change in the liquid pressure. The viscous effects of fluids are neglected, the flow is considered irrotational and the velocity potential is assumed to exist. The governing equations for the translatory motion, size, and deformation of the bubble are derived by perturbation theory. These equations were integrated numerically by the Runge–Kutta method using an IBM 7090 digital computer. The characteristic features in the dynamic behavior of a translating gas bubble were also disclosed in a previous photographic study of a cavitation bubble in a rectangular venuri tube. The validity of the present analysis is borne out in its agreement with experimental observations.
Dissert. Abstr.

**N69-12988** Rensselaer Polytechnic Inst., Troy, N. Y.
**THE EFFECTS OF SURFACE TENSION AND AEROSOLS ON CELLULAR CONVECTION**
John W. Scanlon (Ph.D. Thesis) 1967 95 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-843

A non-linear analysis of cellular convection driven by surface tension in a semi-infinite liquid layer heated from below has been made. The purpose is to determine whether or not one can predict the emergence of the hexagonal flow pattern from the interaction of a certain large class of important disturbances. The principal conclusion is that, compared with gravity driven convection, there is generally a much greater band of imposed temperature difference associated with hexagonal convective patterns. Partial results for the more realistic assumption of finite depth support this conclusion. In addition a preliminary investigation was made of columnar instability, a phenomenon which occurs in the presence of aerosols and whose behavior is not explained by the classical stability theory of thermal convection. A linear analysis was carried out to determine the hydrodynamic effect of an aerosol on the stability of a gas layer heated from below. It was found that aerosols destabilize the system.
Dissert. Abstr.

**N69-12990** Rensselaer Polytechnic Inst., Troy, N. Y.
**AXIAL DISPERSION FROM FLOW NON-UNIFORMITIES IN PACKED BEDS**
Glenn Willard Johnson (Ph.D. Thesis) 1967 161 p
Avail: Univ. Microfilms: HC $7.60/Microfilm $3.00 Order No. 68-829

Axial dispersion in packed beds is analyzed using both the dispersed plug flow model and a non plug flow model which has been previously successfully used for treating dispersion in laminar and turbulent flow in tubes. The velocity profile required for prediction of dispersion with this model was obtained from a model based on the Navier–Stokes equations with an additional term to account for the resistance of the packing. This term allows radial variation in void fraction and particle diameter and predicts their effect on the velocity profile. Numerical solution of the flow model allows the prediction of dispersion coefficients for flow in packed beds. Experimental measurements of dispersion in packed beds were made for uniform packings and for packings which can segregate to give radial variation in particle size. The results obtained compare favorably in both qualitative and quantitative aspects with the predictions as does the data available in the literature.
Dissert. Abstr.

**N69-12992** Stevens Inst. of Tech., Hoboken, N. J.
**STABILITY OF STEADY AND MODULATED PLANE POISEUILLE FLOWS**
Chester E. Grosch (Ph.D. Thesis) 1967 197 p ref
Avail: Univ. Microfilms: HC $9.00/Microfilm $3.00 Order No. 68-1158

The technique of expansion in orthogonal functions has been applied to the study of the linear stability of time-dependent parallel shear flows. The disturbance stream function is expanded in a complete set of functions which satisfy the boundary conditions. The expansion is truncated after N terms, yielding a set of N linear first order differential equations for the time dependence of the expansion coefficients. The technique has been tested on steady plane Poiseuille flow for which the stability characteristics had been calculated with high accuracy. The agreement in both the eigenvalues and eigenfunctions is excellent. For steady plane Poiseuille flow, calculations have been carried out for a wide range of Reynolds numbers and disturbance wave numbers. Both symmetric and antisymmetric disturbances have been considered.
Dissert. Abstr.

**N69-12993** Brown Univ., Providence, R. I.
**LOW REYNOLDS NUMBER FLOW OF PARTICULATE FLUIDS**
Ralph Brooks Turner (Ph.D. Thesis) 1967 82 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-1509

Using an integral form (obtained by Lorentz) of the solution of the problem of uniform motion of a sphere in an otherwise quiescent fluid, an approximation, based on the sphere size, of the motion produced by a sphere which translates and rotates uniformly

in an arbitrary, Stokesian flow field is obtained. The force and torque on such a sphere are given by the formulas of Faxen. These formulas are extended to include those problems for which the unperturbed flow is not of the Stokes type, but for which the Reynolds number based on sphere size is very small. The extended Faxen formulas are shown to be valid if the unperturbed flow field contains boundaries, such as other particles and walls. These extended formulas are then used to approximate the interaction force and torque between two spheres which move in an arbitrary background flow field. The interaction force is in turn used to obtain viscosity corrections for a fluid which in its unperturbed state is quiescent and has spherical particles suspended in it.
Dissert. Abstr.

**N69-13053#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ON LEADING OUT ELECTRON BEAMS FROM VACUUM INTO A GAS THROUGH A GAS DYNAMIC WINDOW**

A. M. Trokhan *In its* J. of Appl. Mech. and Tech. Phys. 5 Dec. 1967 p 14–19 refs (See N69-13051 03-34)
Avail: CFSTI

While it is possible to use small capillary tubes to extract low intensity electron beams from a vacuum system for injection into a gas at some higher pressure, for high intensity beams the backflow of gas into the vacuum system constitutes a problem. In this connection it is customary to employ differential gas dynamical windows, where pumps are used to evacuate an intermediate chamber between vacuum and gas systems. In this paper a new design is discussed in which the pumps are replaced by a cryogenic apparatus reducing the flow of gas into the vacuum by condensation. The intermediate space is filled with cold $CO_2$ or water vapor serving as the refrigerant. This method has the advantages of being less bulky and of introducing no vibration into the gas confining system. Windows with a diameter of 15–20 mm have been constructed, in contrast with diameters of 3–4 mm permitted by the use of pumps. An example of such a design is shown schematically.
Author

**N69-13054#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**EXTENDING THE LIMITING RELATIVE LAWS GOVERNING FRICTION AND HEAT TRANSFER TO INCLUDE NONISOTHERMAL GAS FLOW WITH FINITE REYNOLDS NUMBERS NUMBERS**

A. I. Leont'yev et al *In its* J. of Appl. Mech. and Tech. Phys. 5 Dec. 1967 p 20–26 refs (See N69-13051 03-34)
Avail: CFSTI

The skin friction and heat transfer data in the literature are reviewed in detail to show that limiting friction and heat transfer laws, calculated theoretically, are also applicable to nonisothermal flows with finite Reynolds numbers. This is shown to be possible if local skin friction coefficients $C_{f0}$ and local Stanton numbers $S_0$ are defined. Introduction of $C_{f0}$ in the ratio allows one to calculate nonisothermal turbulent boundary layers from the limiting expressions without including the effects of finite Reynolds numbers. The same procedure can be followed for the heat transfer laws.
Author

**N69-13130#** United Kingdom Atomic Energy Authority, Wantage (England). Research Group.

**DISPERSION AND MIXING DURING TURBULENT FLOW OF WATER IN A CIRCULAR PIPE**

C. G. Clayton, A. M. Ball, and R. Speckman May 1968 33 p refs
(AERE-R-5569) Avail: Issuing Activity

The dispersion of a tracer continuously injected into a 4 in. dia pipe containing water in turbulent motion was investigated experimentally over the flow range $5 \times 10^3 < Re < 5.5 \times 10^5$ by observing the distribution of the tracer over various cross-sections downstream from the injection region. The effect of four different injection systems was examined and it was found that, of the arrangements tried, the shortest mixing distance occurs when the tracer is injected through equally spaced orifices at a radius of 0.63 in. of the pipe radius. A small increase of mixing distance with increasing Reynolds number was established. The agreement between the experimental results and results derived theoretically was sufficiently close for the theory to be considered of general practical use.
Author (NSA)

**N69-13174** Tulane Univ., New Orleans.

**A MODEL ANALYSIS OF TWO TURBULENT INTERACTING JETS**

Kil Chul Kwack (Ph.D. Thesis) 1967 94 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 67-17928

In this study two turbulent jets arranged with axes intersecting at some point downstream are considered. The flow is two dimensional, incompressible, and of low velocity. A common wall is provided at the exit of the jets so that no inflow is allowed to mix with ambient air. Then, the entrainment of air across the edge of inner part of individual jets increases with the jet width but reduces static pressure between the jets near the wall and, as a consequence, produces pronounced negative gauge pressure and a transverse pressure gradient along the jet causing them to curve inward concavely and to merge. Since there may be a reduced entrainment along the inner edge and an enhanced entrainment along the outer edge due to centrigugal force acting on fluid lumps, by introducing a modified mixing length, an exact solution of the curved jets is sought as a function of jet width and radius of curvature which are related to a measure of the rate of entrainment.
Dissert. Abstr.

**N69-13261#**

**APPROXIMATE COMPUTATION OF SUPERSONIC FLOW INTERACTION WITH A LAMINAR LAYER IN THE SEPARATION FLOW DOMAIN**

E. N. Bondarev [1968] 7 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekhan. Zhidk. i Gaza (USSR), no. 5, 1966 p 118–120
Avail: CFSTI

Distributions of the pressure, friction and heat transfer coefficients in the zone of laminar boundary layer separation ahead of a wedge on a plate are computed. The Cohen-Reshotko integral method is used to compute the flow in the boundary layer.
Author

**N69-13290#** National Physical Lab., Teddington (England). Aerodynamics Div.

**THE FLOW AROUND A CIRCULAR CYLINDER IN THE CRITICAL REYNOLDS NUMBER REGIME**

P. W. Bearman Jan. 1968 29 p refs
(NPL-AERO-1257) Avail: CFSTI

The flow around a circular cylinder in the critical Reynolds number régime has been examined in both smooth and highly turbulent air flow. Narrow-band vortex shedding was observed in smooth flow up to a Reynolds number of $6.5 \times 10^5$. In turbulent flow the critical Reynolds number was found to be a function of the turbulence parameter. Narrow-band vortex shedding was observed in turbulent flow at subcritical Reynolds numbers. Spectra of velocity fluctuations measured in the wake are presented for both smooth and turbulent free streams.
Author (ESRO)

**N69-13306#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**UNSTEADY CONVECTIVE HEAT EXCHANGE AND HYDRODYNAMICS IN CHANNELS**

E. K. Kalinin *In its* Nuclear Reactor and Heat Exchanger Thermal Dynamics 14 Aug. 1967 p 33–53 refs (See N69-13303 03-22)
Avail: CFSTI

This article is devoted to processes that occur in heat power installations during startup, emergency shutdown, and transients, and to a determination of the kinetics of the processes occurring in such systems and means of automatically controlling them. The heat transfer coefficient, which is an important function in the calculation of stationary phenomena, is redefined to include nonstationary effects and to procedures for determining the heat transfer coefficient and the hydraulic resistance under nonstationary conditions. The article consists of two parts, one describing various methods of experimentally determining the nonstationary heat transfer coefficient and solving the empirical equations that are derivable from the experiments, and the other devoted to a procedure for determining the nonstationary coefficient of hydraulic resistance. The various published procedures for these purposes are briefly summarized and their advantages and disadvantages discussed. The article is based on material obtained by a detailed survey of literature on nonstationary heat exchange and hydrodynamics.
Author

**N69-13323#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DEVELOPMENT OF THE FLOW OF A VISCOUS LIQUID WITH ANISOTROPIC CONDUCTIVITY IN A CHANNEL [RAZVITIYE TECHENIYA VYAZKOY ANIZOTROPNO PROVODYASHCHEY ZHIDKOSTI V KANALE]**
V. V. Breev et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 97–112 refs (See N69-13314 03-03)
(SM-74/103) Avail: CFSTI

When liquid flows along a channel, the initial profile of the velocity distribution at the entrance is deformed into a fully developed profile at a certain distance from the entrance. The length in the channel over which this deformation of the velocity profile takes place is called the initial section. In view of the fact that the length of an MHD generator channel is usually appreciably smaller than the initial section, a detailed investigation of the flow development is of great interest. But even for the laminar flow of an incompressible nonconducting liquid, the problem of flow development does not have an exact solution because of the nonlinear inertial terms in the equation of motion. A number of studies were devoted to the problem of the development of flow of an isotropically conducting liquid, and are reviewed. The drawback of all the methods mentioned is that the error caused by the simplifications cannot be estimated quantitatively. A solution without any restriction is given.
Author

**N69-13353#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SOME OBSERVATIONS OF MERCURY FLOW IN A TROUGH IN A TRANSVERSE MAGNETIC FIELD [NEKOTORYYE NABLYUDENIYA TECHNIYA RTUTI V LOTKE V POPERECHNOM MAGNITNOM POLE]**
L. A. Vulis et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 431–447 refs (See N69-13314 03-03)
(SM-74/249) Avail: CFSTI

The study of the motion of an incompressible liquid with a free surface, in a magnetic field, is of interest, particularly for the comparison of experimental and computational results. In accordance with the known hydro-gaseous analogy developed for the flow in a magnetic field this relatively simple form of motion can serve also as a qualitative model for the flow of a conducting gas (plasma) in channels. The investigation of the flow of a conducting liquid in a trough in a magnetic field provides the possibility of exposing some characteristics of magnetohydrodynamic continuous flow with hydraulic jump. The results of the experiments corroborate the qualitative conclusions drawn from the analysis of the equations of the reversal of effects, and confirm the possibility of using approximate computation based on the one dimensional scheme.
Author

**N69-13392#** Von Karman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium).
**THE MEASUREMENT OF DRAG FORCES IN LOW DENSITY FLOWS**
J. J. Smolderen, J. F. Wendt, and J. Naveau 1968 22 p refs In FRENCH; ENGLISH summary
(VKI-TN-44) Avail: CFSTI

A new technique to accurately measure low level forces and its application to the determination of drag coefficients in rarefied hypersonic flow are described. Preliminary results are presented for cylinders and spheres at M = 8 in the transitional and near-free molecule flow regimes.
Author (ESRO)

**N69-13396#** Massachusetts Inst. of Tech., Cambridge. Dept. of Mathematics.
**THE THEORY OF ROTATING FLUIDS Interim Report**
H. P. Greenspan Sep. 1968 382 p refs
(Grants AF-AFOSR-492-64; AF-AFOSR-492-66)
(AD-676-258; AFOSR-68-2018) Avail: CFSTI CSCL 20/4

The monograph gives the first unified and comprehensive account of the theory of rotating fluids. The mathematical development focuses on fundamental principles as revealed through the systematic study of simply constructed experiments, many of which are described for the first time. Special features of the book include a separate chapter devoted to non-linear processes and methods of solution, several sections reporting the results of previously unpublished research, and the identification of important unsolved problems. The discussion of basic concepts also allows for a wide range of engineering applications and a chapter is devoted to the laboratory simulation of large-scale oceanic circulations. The book will be of direct use to many applied mathematicians, engineers and physical oceanographers.
Author (TAB)

**N69-13431#** Aeronautical Research Council (Gt. Brit.)
**MEASUREMENTS IN A THREE-DIMENSIONAL TURBULENT BOUNDARY LAYER IN SUPERSONIC FLOW**
M. G. Hall and H. B. Dickens Supersedes RAE-TR-66214; ARC-28599; see N68-17303
(ARC-R&M-3537; RAE-TR-66214; ARC-28599) Avail: CFSTI

In this Report the details are given of the results of measurements of mean values in time of pitot pressure and flow direction made in the boundary layer over the insulated side-wall of a specially constructed supersonic nozzle. The external flow first accelerated and then decelerated, and the crosswise pressure gradients were such that the boundary-layer cross-flow was first in one direction and then in the opposite, as happens over wings with swept leading edges. The external Mach number ranged between 1.6 and 2.0. Boundary-layer traverses were made at intervals along external streamlines; from each traverse, profiles of Mach number and streamwise and cross-wise components of velocity were derived. The results were supplemented by measurements of skin friction using surface tubes, and displacement and momentum thicknesses were evaluated. All the results are presented in tabular form, and a discussion is given in which serious limitations in the commonly assumed forms for the cross-flow profiles are pointed out. There is evidence, however, that the streamwise component behaves as it would in an equivalent two-dimensional boundary layer.
Author (ESRO)

**N69-13434#** National Physical Lab., Teddington (England). Aerodynamics Div.
**BOUNDARY-LAYER PROBLEMS OF 1967**

P. Bradshaw Sep. 1967 12 p refs
(NPL-AERO-1253; ARC-29718) Avail: CFSTI

Laminar and turbulent boundary layer problems studied during 1967 are reviewed for the ARC Fluid Motion Subcommittee and a list of 58 references shows the progress made in some of the topics similarly reviewed in 1966. ESRO

**N69-13506#** McGill Univ., Montreal (Quebec). Mechanical Engineering Research Lab.

**REYNOLDS STRESSES IN FULLY DEVELOPED TURBULENT FLOW DOWN A CIRCULAR PIPE**

Rajni P. Patel Oct. 1968 64 p refs
(Grant DRB-G-9551-12)
(Rept-68-7) Avail: CFSTI

Measurements of Reynolds stresses in turbulent flow down a circular pipe using a hot-wire anemometer are presented. In particular the effect of the parallel component of velocity on turbulence measurements with inclined wires is investigated. In addition relevant measurements of velocity distributions and turbulence energy spectra are also reported. A verification of Champagne's conclusion regarding the effect of the parallel component of velocity on inclined hot-wire is obtained for dynamic conditions by measurements of apparent shear stress. In view of the fact that the correction due to parallel component of velocity is moderately small, flow through the pipe was thoroughly checked and it was noted that use of a pitot tube alone does not confirm the state of the flow, i.e. whether it is independent of upstream history or not. For turbulent flow through a pipe to be practically independent of upstream history this investigation suggests that L/D should be greater than about 100 and Reynolds numbers (based on entry length and friction velocity, should be greater than about $10^6$. Author

**N69-13520#** Massachusetts Inst. of Tech., Cambridge. Aerophysics Lab.

**APPLICATION OF THE METHOD OF PARAMETRIC DIFFERENTIATION TO RADIATION GASDYNAMICS**

Martin C. Jischke Jul. 1968 298 p refs
(Contract AF 49(638)-1621)
(AD-676671; AFOSR-68-1862) Avail: CFSTI CSCL 16/4

It is shown that the method of parametric differentiation, used in solving nonlinear systems of equations, can be interpreted as a device for introducing a real parameter characteristic into the mathematical description of the problem along which one can integrate the parametrically differentiated system of equations. In this way, the method of parametric differentiation yields a characteristic initial value problem where the necessary data along distinct families of characteristics are the parametrically differentiated boundary conditions of the original problem and a solution of the original system for a particular value of the descriptive parameter. The applicability of the method of parametric differentiation to problems in radiation gasdynamics is first indicated by the solution of a simple test problem - the one-dimensional, hypersonic, radiating shock layer. Treating the total optical depth of the shock layer as the descriptive parameter, solutions were obtained for a large range of values of this parameter which appeared to be consistent with existing approximate solutions. The utility of this technique in radiation gasdynamics is further demonstrated in a solution of the problem of an inviscid, radiating gas flow in the stagnation region of a blunt body. Author (TAB)

**N69-13551#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**THE USE OF INTEGRAL RELATIONSHIPS FOR AN APPROXIMATE SOLUTION OF PROBLEMS IN FLUID MECHANICS AND HEAT EXCHANGE DURING PROPAGATION OF JETS OF INCOMPRESSIBLE FLUID ALONG A FLAT WALL [PRIMENENIE INTEGRALNYKH SOOTNOSHENII K PRIBLIZHENNOMU RESHENIYU ZADACH GIDROMEKHANIKI I TEPLOOBMENA PRI RASPROSTRANENII STRUY NESZHIMAEMOI ZHIDKOSTI VDOL PLOSKOI STENKI]**

N. V. Klientov Aug. 1967 16 p refs Transl. into ENGLISH from Teplo- Massoperenos (USSR), v. 2, 1965 p 420-432
(AD-676570; FTD-HT-23-970-67) Avail: CFSTI CSCL 20/4

A simple method is proposed for solving planar and axisymmetric heat exchange problems on propagation of laminar and turbulent jets of incompressible fluid along an infinite plane wall. It is assumed that a plane jet of gas flows from an infinitely thin slit and is propagated along one side of a flat wall, while an axisymmetric jet flows from a radial diffuser or point source and is propagated along an infinite plane barrier. The slit and radial diffuser are located in the plane of the wall along which the jet is propagated. It is assumed that the density and viscosity of the gas are constant and that the flow is steady. To be determined are the basic flow and heat exchange characteristics during propagation of laminar and turbulent jets of incompressible gas along a wall at low temperature gradients. TAB

**N69-13622#** Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.

**A HYDRODYNAMIC THEORY OF DESALINATION BY ELECTRODIALYSIS**

Ain A. Sonin and Ronald F. Probstein Jun. 1968 62 p refs
(Publ.-68-4) Avail: Issuing Activity

A hydrodynamic theory of demineralization by electrodialysis has been developed for a multichannel system with steady laminar flow between plane, parallel membranes. The modeling of the system is found to be governed by four basic similarity parameters: (i) a dimensionless applied potential, (ii) the product of the channel aspect ratio and the inverse Péclet number, (iii) the ratio of brine and dialysate inlet concentrations, and (iv) a parameter measuring membrane resistance. For sufficiently long channels it is shown that there are two distinct regions: a "developing" region where the concentration diffusion layers are growing, and a "developed" region where the diffusion layers fill the channel. Parabolic and uniform velocity profiles are considered and self-consistent solutions are derived for the distributions of salt concentration, electric field and current density in the system, as well as for the total current. Author

**N69-13645#** Aerospace Research Labs., Wright-Patterson AFB, Ohio.

**A LIMITING CONDITION FOR SUPERSONIC INVISCID INTERACTION IN THE CORNER OF INTERSECTING WEDGES Final Report**

Robert H. Korkegi May 1968 35 p refs
(AD-676643; ARL-68-0099) Avail: CFSTI CSCL 20/4

The flow structure in the corner of intersecting wedges of equal angle in inviscid supersonic flow is investigated based on the assumption that the attached bow waves of the wedges remain planar up to their line of intersection. The flow structure is looked at from the intersection of the bow waves in toward the corner and found to consist of a succession of shock reflections required to eventually bring the flow in alignment with the intersection of the wedges. Calculations for several corner configurations show that, while the shock reflections initially move in toward the corner (physically possible), subsequent ones begin to move outward (physically impossible). It is concluded that the bow waves of the wedges cannot remain planar up to their intersection, for finite wedge angles in inviscid supersonic flow, and therefore, a break must exist in the corner region of the bow waves which must then be joined by an intermediate shock configuration. Author (TAB)

N69-13675# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
**ON THE DERIVATION OF THREE-DIMENSIONAL SECOND ORDER ACCURATE HYDRODYNAMIC DIFFERENCE SCHEMES**
Ephraim L. Rubin and Stanley Preiser Jul. 1968 20 p refs
(Contract Nonr-839(34))
(AD-676317; PIBAL-68-24) Avail: CFSTI CSCL 20/4

The paper indicates how a second order accurate two step method used in the numerical computation of hydrodynamic flows may be derived directly from the integral conservation laws. The result of Anderson, Preiser and Rubin makes it immediately applicable to arbitrary orthogonal curvilinear coordinate systems. A necessary and sufficient condition for stability is derived for the three-dimensional Cartesian coordinate case. Author (TAB)

N69-13733# Rutgers Univ., New Brunswick, N. J. Dept. of Mechanical and Aerospace Engineering.
**SEPARATED FLOWS Annual Report, Sep. 1, 1967–Aug. 31, 1968**
Robert H. Page Sep. 1968 45 p refs
(Contract F44620-68-C-0018; Proj. Themis)
(AD-676287; RU-TR-120-MAE-F) Avail: CFSTI CSCL 20/4

A brief review of the Project Themis research program in Separated Flows at Rutgers is presented. The review covers the period 1 September 1967 to 31 August 1968. During the year the following projects have been underway: (1) Smooth wall separation in oscillating flow, (2) Turbulent subsonic axisymmetric near-wake, (3) Convective heat transfer in separated flow, (4) Supersonic axisymmetric near-wake, (5) Nonequilibrium processes in separated flow, (6) Numerical methods for free shear layer problems, and (7) Flow reattachment. The personnel involved, progress during the year, and future plans are given for each project. Author (TAB)

N69-13770# Ballistic Research Labs., Aberdeen Proving Ground, Md.
**DESHOCKING ERROR IN THE ANALYSIS OF INTERFEROGRAMS**
James W. Bradley Sep. 1968 23 p refs
(AD-676827; BRL-MR-1936) Avail: CFSTI CSCL 20/4

The zone method of analysis of an axisymmetric interferogram of supersonic flow usually requires the introduction of a deshocking constant B sub o to reduce the undesirable mathematical effects of the density jump at the shock. This report derives an expression for the error associated with the use of an incorrect deshocking constant, C sub o. It is shown that for a given trace, (1) the error at the first zone point inside the shock depends only on B sub o and C sub o and (2) the error at any other point depends only on B sub o, C sub o and the manner in which the trace is divided into zones. A proof is given that the error dies out away from the shock, regardless of the estimate C sub o or of the manner of zone division. Author (TAB)

N69-13795*# Dynatech Corp., Cambridge, Mass.
**DIELECTROPHORETIC CONTROL OF PROPELLANT SLOSH IN LOW GRAVITY Final Report, 5 Jan. 1966–31 Mar. 1968**
Mathew Hurwitz and James R. Melcher 31 Mar. 1968 81 p refs
(Contract NAS8-20553)
(NASA-CR-98168; DYNATECH-769) Avail: CFSTI CSCL 20D

Analyses, experiments, and design evaluations were conducted to study the feasibility of using electrohydrodynamic (EHD) forces to stabilize a sloshing cryogenic propellant. An electrode configuration was conceived which provides a significant stiffening influence on the liquid/vapor interface when located just below the sloshing surface. As the sloshing interface passes from the field-free region, outside the electrode array, to the region of strong electric field within the array, the EHD surface force "bangs" on abruptly. Experiments are described which demonstrate the influence of this EHD bang-bang phenomenon on modes of fluid oscillation. It is further demonstrated that liquids such as Freon 113 and liquid nitrogen can be suspended in a stable equilibrium over a gas in an adverse accelerations as great as 1g. Experimental measurements of slosh frequency and interfacial stability are correlated with a theoretical model which includes the salient nonlinear features of the dynamics. Experiments with ac and dc fields are reported. The use of dc fields is demonstrated to be potentially feasible for EHD propellant orientation systems. A conceptual hardware design and weight analysis is presented for an EHD slosh baffle for the S-4B hydrogen tank. Author

N69-13803# Los Alamos Scientific Lab., N. Mex.
**MISCELLANEOUS OBSERVATIONS ON FILM FLOW**
L. J. Campbell, E. F. Hammel, D. M. Jones, and W. E. Keller [1967] 7 p refs Presented at Conf. on Low Temp. Phys., St. Andrews, Scotland
(Contract W-7405-eng-36)
(LA-DC-9731; CONF-680808-4) Avail: CFSTI

Simple level-sensing devices, previously shown to be useful for probing the relative chemical potential in the flowing He(II) film, were used to investigate several aspects of dissipation in the film when flow is initiated by either gravitational or thermal gradients. NSA

N69-13863# California Univ., Berkeley. Div. of Aeronautical Sciences.
**INVESTIGATION OF SKIMMER INTERACTION INFLUENCES ON THE PRODUCTION OF AERODYNAMICALLY INTENSIFIED MOLECULAR BEAMS**
Ulf Bossel (Ph.D. Thesis) Aug. 1968 270 p refs
(Contract Nonr-222(45))
(AD-676911; AS-68-6) Avail: CFSTI CSCL 20/4

An intensive investigation of the dependence of the intensity on various dynamic and geometric quantities was conducted for nozzle beams skimmed from large, quasi-inviscid free jets of nitrogen and argon. Additional measurements of the total skimmer flux, the beam profiles and speed distribution were made and compared to the observed beam intensity for a sample case. It was possible to collect enough information under conditions free from background and condensation effects to recognize the main contributions to the beam attenuation. The results illustrate the validity of the original Kantrowitz-Grey idealization as a limiting form. Restrictions are apparently imposed by effects of condensation and polymerization, the presence of shock waves, typical rare-fraction phenomena, and ill-designed skimmer-and wall geometries. The interpretation of the observed scattering attenuation leads to a semitheoretical description of the beam flux and consequently to the prediction of a system-specific optimum beam intensity and an optimum skimmer diameter depending only on the performance of the nozzle exhaust and skimmer exhaust system. Author (TAB)

N69-13880# RAND Corp., Santa Monica, Calif.
**ON THE HYPERSONIC LEADING-EDGE PROBLEM IN THE MERGED-LAYER REGIME**
H. K. Cheng (Univ. of Southern Calif.), S. Y. Chen, R. Mobley, and C. Huber Sep. 1968 15 p refs Presented at the 6th Rarefied Gas Dyn. Symp., Cambridge, Mass., 22–26 Jul. 1968
(AD-676835; P-3935) Avail: CFSTI CSCL 20/4

Finite-difference analyses are applied to a single set of partial differential equations derived from full Navier-Stokes equations under a thin-layer approximation for the entire flow field (including the shock-like region). Solutions obtained for the caloric perfect gas are compared with available data from air and nitrogen experiments. Calculated values for heat-transfer appear to be higher than

measured data; examination indicates that certain nonequilibrium effects (rotational de-excitations in particular), unaccounted for in data correlation and in the analysis, may be important sources of the discrepancy. Author (TAB)

# 13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

**N69-12694** Arizona Univ., Tucson.
**THE DETERMINATION OF ATMOSPHERIC PROPERTIES BY THE MATHEMATICAL INVERSION OF THE RADIATIVE TRANSFER EQUATION**
Douglas Neal Yarger (Ph.D. Thesis) 1967 140 p
Avail: Univ. Microfilms: HC $6.60/Microfilm $3.00 Order No. 67-16515

A method for the determination of the vertical distribution of ozone from a satellite is discussed in this dissertation. The equation of radiative transfer is inverted using a technique originated by Phillips and further developed by Twomey. The inversion is based on simulated measurements from the top of the atmosphere of the ultraviolet radiation backscattered from the earth's atmosphere. Solutions are presented only for a plane-parallel atmosphere but consider all orders of scattering and polarization. Although the method lacks practical application at this time, the results indicate that the inversion procedure presented would provide a potentially superior method of monitoring the vertical distribution on a world-side basis using a satellite if spherical effects could be included in the theory. A second differencing constraint is used in the inversion method, hence there is no bias toward some standard distribution. Dissert. Abstr.

**N69-12701#** Institutes for Environmental Research, Boulder, Colo.
**CONJUGATE POINT SYMPOSIUM, VOLUME 3, SESSION 4**
Jul. 1967 241 p refs Conf. held at Boulder, Colo., 13–16 Jun. 1967; Sponsored by ESSA and High Altitude Obs.
(AD-661272; IERTM-ITSA-72) Avail: CFSTI

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15. EXAMINATION OF STORM TIME OUTER ZONE ELECTRON INTENSITY CHANGES AT 1100 KILOMETERS J. F. Arens and D. J. Williams (NASA, Goddard Space Flight Center) 4 p ref (See N69-12716 03-13)

**N69-12702#** Denver Univ., Colo. Dept. of Physics.
**GENERAL REMARKS ON CONJUGATE POINT PHENOMENA**
Juan G. Roederer *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 10 p refs (See N69-12701 03-13)
Avail: CFSTI

Conjugate point analysis involves magnetic particles, waves, or fields travelling along a geomagnetic field line that intersects the lower ionosphere or the earth's surface. Conjugate point experiments are used to gather information about geomagnetic source mechanisms, whistler propagation along field lines, and diurnal and seasonal variations in field line geometry. Basic classes of conjugate point phenomena are: (1) those in which the original process information is located on or around the equator; (2) those in which the source is located at or around one of the "end" points of the field line; and (3) those seen at the ends of open field lines, which reach out into the night and come close to the common region in the neutral sheet of the magnetospheric tail where the source is located. G.G.

**N69-12703*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**GEOMAGNETIC EULER POTENTIALS**
David Stern *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 9 p refs (See N69-12701 03-13)
Avail: CFSTI CSCL 08N

Euler potentials are used to build models of the external magentosphere in which the expansion of the scalar potential includes terms increasing with distance. The magnetic field is thus represented as the cross product of the gradients of two scalars and each field line is labeled by a pair of constant values. G.G.

**N69-12704*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**THE ROLE OF THE MAIN GEOMAGNETIC FIELD IN LOCATING CONJUGATE POINTS**
Joseph C. Cain *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 20 p refs (See N69-12701 03-13)
Avail: CFSTI CSCL 08N

A sample distribution of conjugate points is calculated using various models of the main geomagnetic field evaluated at different epochs. A summary of the conclusions is that: (1) for L < 4 the errors are of the order of a few tens of kilometers; (2) older models of the field such as Finch-Leaton give results within a few degrees of the latest more accurate models; (3) use of the eccentric dipole approximation gives errors that range from a few tens of kilometers at high latitude to several hundred kilometers near the equator; and (4) the secular change of conjugate point locations is very small, averaging 1 to 10 Km/yr. Inclusion of Mead's symmetrical boundary field for a trace from Macquarie Island to Alaska (L = 5) shifts the conjugate only about 100 Km. It is concluded that for L ≥ 5 the field line passes through regions where the field intensity is sufficiently weak that conjugate point determinations should include realistic estimates (not now available) of the distortions due to plasma interactions. Author

**N69-12705#** Institute for Telecommunication Sciences and Aeronomy, Boulder, Colo.

**WORLD MAPS OF CONJUGATE COORDINATES AND L CONTOURS**

W. H. Campbell and S. Matsushita (High Altitude Obs.) *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 7 p refs Supported in part by ARPA (See N69-12701 03-13)

Avail: CFSTI

A modified computer program was used to analyze particle motion in a model magnetosphere and to plot conjugate locations and L parameter values for 10° geographic latitude and longitude intersections at 100 km altitudes above the earth's surface. Obtained maps show smoothed interpolations between computed values of conjugate locations and some contours of the constant L. At high latitudes, particularly at L greater than 6, this parameter started to lose its significance as did the conjugate location itself. G.G.

**N69-12706#** New Hampshire Univ., Durham. Space Science Center.

**MAGNETOSPHERE INFLATION ENERGY FOR FOUR STORMS IN 1965**

L. J. Cahill *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 13 p refs (See N69-12701 03-13)

Avail: CFSTI

Location and decay rates of the inflation energy in several magnetospheric storms were studied. Analyses of observational satellite data supported the theory that ionospheric F region heating, atmospheric heating, and stable auroral red arcs may result from dissipation of magnetic storm inflation energy; the highest dissipation rates were found at asymmetric inflation. Morning to afternoon asymmetry was present in some storm related observations. G.G.

**N69-12707#** Tokyo Univ. (Japan). Inst. Space and Aeronautical Science.

**SOME PROBLEMS ON MAGNETOSPHERIC TAIL**

Tatsuzo Obayashi *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 20 p refs (See N69-12701 03-13)

Avail: CFSTI

The flapping motions of the earth's geomagnetic tail are attributed to: (1) structural changes in solar winds streaming upon the geomagnetic field; (2) various gas dynamic instabilities at the magnetopause; and (3) effects of wake vortices produced behind the magnetosphere. G.G.

**N69-12708*#** Alaska Univ., College. Geophysical Inst.

**POLAR MAGNETIC SUBSTORMS IN THE CONJUGATE AREA**

C.-I. Meng and S.-I. Akasofu *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 22 p refs (See N69-12701 03-13)

(Grants NsG-201-62; NSF GA-505)

Avail: CFSTI CSCL 04A

Using simultaneous records of polar magnetic substorms from two pairs of geomagnetically conjugate stations (College-Macquarie; Reykjavik-Syowa), it is shown that the magnitude of positive bays is mainly controlled by the ionization produced by solar wave radiation, not by the intense auroral particle bombardment which is the major factor for negative bays. It is also shown that the pattern of the polar electrojet with respect to the dipole pole is displaced or different in the two polar caps, particularly in the solsticial months. The electrojet appears further toward the pole in the winter polar cap than in the summer one. These results bear on the configuration of the geomagnetic field lines in the magnetospheric tail, if auroral particles originate there. Author

**N69-12709#** Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.

**MORPHOLOGY OF ELEMENTARY MAGNETOSPHERIC SUBSTORMS**

Neil Brice *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 20 p refs (See N69-12701 03-13)

(Grants AF-AFOSR-783-66; NSF GA-878)

Avail: CFSTI

Investigated are burst mechanisms that cause night time auroras and associated electron precipitation and their relationships to disturbances in other parts of the magnetosphere. Analyses of average precipitation patterns for energetic electrons establish a statistical correlation between high latitude disturbance phenomena and either soft or hard precipitation patterns. Night time sudden disturbances are often seen simultaneously on magnetometers, riometers, photometers, micropulsation recorders, and VLF hiss recorders. These sudden onsets correspond with the overhead passage of the poleward expanding auroral bulge during auroral substorms. G.G.

**N69-12710#** Dominion Observatory, Ottawa (Ontario).

**SPATIAL EXTENT OF GEOMAGNETIC EVENTS CONJUGATE TO BYRD**

J. K. Walker *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 15 p refs (See N69-12701 03-13)

Avail: CFSTI

Five magnetometers in an east-west line and centered on the Byrd conjugate point were operated during October 1963. The correlation of the hourly range was highest between Byrd and Cape Jones, the central station, but the maximum correlation was west of the Byrd conjugate point during the morning and east after local noon. The coherency between these stations during storms or pulsations was highest for periods greater than 30 minutes. At periods from 1.5 to 30 minutes the coherency was less than .5 except when pc 4s occurred. The coherency was slightly higher for the amplitude of the horizontal disturbance vector than for the H component and the total force disturbance vector, while the Z component had the lowest coherency. The distribution of the pc 4 polarization diagrams with the best fit to the Byrd diagram was centered on the Byrd conjugate point as were the pulsations with the same amplitude. Author

**N69-12711*#** California Univ., Los Angeles. Dept. of Planetary and Space Science.

**SIMULTANEOUS MAGNETIC FIELD VARIATIONS AT THE EARTH'S SURFACE AND AT SYNCHRONOUS, EQUATORIAL DISTANCE. 1: BAY-ASSOCIATED EVENTS**

W. D. Cummings and P. J. Coleman, Jr. *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 9 p (See N69-12701 03-13)
(Contract NAS5-9570)
Avail: CFSTI CSCL 08N

Reported are preliminary results of synchronous satellite magnetometer readings on simultaneous disturbances of magnetic fields perpendicular and parallel to the spin axis of the satellite. Data obtained show that at least some high latitude geomagnetic bays are associated with disturbances in the distant magnetosphere and that field aligned currents are influential in these events G.G.

**N69-12712*#** California Univ., Los Angeles. Dept. of Planetary and Space Science.
**SIMULTANEOUS MAGNETIC FIELD VARIATIONS AT THE EARTH'S SURFACE AND AT SYNCHRONOUS, EQUATORIAL DISTANCE. 2: MAGNETIC STORMS**
P. J. Coleman, Jr. and W. D. Cummings *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 13 p ref (See N69-12701 03-13)
(Contract NAS5-9570)
Avail: CFSTI CSCL 04A

Magnetic field measurements onboard a synchronous equatorial earth satellite during geomagnetic storms show that the H component at the satellite was 20 to 30 $\gamma$ above its quiet day values at the initial phase before it decreased to 70 $\gamma$ below quiet day values during the main phase. This was always followed by a bay-related increase in H. G.G.

**N69-12713*#** Rice Univ., Houston, Tex. Dept. of Space Science.
**GROSS LOCAL TIME PARTICLE ASYMMETRIES AT THE SYNCHRONOUS ORBIT ALTITUDE**
J. W. Freeman, Jr. and J. J. Maguire *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 18 p refs (See N69-12701 03-13)
(Contract NAS5-9561)
Avail: CFSTI CSCL 04A

A low energy charged particle detector has been flown aboard the geostationary ATS-1 satellite. A preliminary study of the data has revealed large local time variations in the particle fluxes observed during geomagnetically disturbed times. The salient features of the observed variations are: 1) During periods of moderate magnetic activity a high particle flux is seen near local midnight. This flux shows a strong pre/post-midnight asymmetry with the particle intensities being higher in the midnight to dawn quadrant. 2) During periods of high magnetic activity the enhanced particle flux distribution broadens out in local time to cover a larger fraction of the night side portion of the synchronous orbit. 3) During periods of enhanced magnetic activity the local time distribution of the particle fluxes shows a remarkable similarity to the local time distribution of high latitude magnetic substorm activity. Author

**N69-12714*#** Minnesota Univ., Minneapolis. Dept. of Physics and Astronomy.
**CONJUGATE EFFECTS ON ENERGETIC ELECTRONS BETWEEN THE EQUATOR AT 6.6 $R_e$ AND THE AURORAL ZONE. PART 1**
T. W. Lezniak, R. L. Arnoldy, G. K. Parks, and J. R. Winckler *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 11 p refs (See N69-12701 03-13)
(Contract NAS5-9542; Grant NSF GA-487)
Avail: CFSTI CSCL 04A

Synchronous satellite measurement data on energetic electron behavior during quiet and disturbed times show large positive deviations after local midnight with sharp commencement at local midnight. Particles which normally do not appear on quiet day passes suddenly are present at local midnight and in the sector from midnight to about noon as a result of magnetic disturbances. These particles have a life time on the particle shell passing through 6.6$R_e$ at local midnight which is less than their drift time around the earth. G.G.

**N69-12715*#** Minnesota Univ., Minneapolis. Dept. of Physics and Astronomy.
**CONJUGATE EFFECTS ON ENERGETIC ELECTRONS BETWEEN THE EQUATOR AT 6.6 $R_e$ AND THE AURORAL ZONE. PART 2**
G. K. Parks, R. L. Arnoldy, T. W. Lezniak, and J. R. Winckler *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 18 p refs (See N69-12701 03-13)
(Contract NAS5-9542; Grant NSF GA-487)
Avail: CFSTI CSCL 04A

The comparison of energetic electron flux measurements at 6.6$R_e$ equatorial plane with precipitated energetic electron fluxes measured by high altitude balloons established a correlation between time variations of trapped electrons with precipitation of energetic electrons in the auroral zone. G.G.

**N69-12716*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**EXAMINATION OF STORM TIME OUTER ZONE ELECTRON INTENSITY CHANGES AT 1100 KILOMETERS**
John F. Arens and Donald J. Williams *In* Inst. for Environ. Res. Conjugate Point Symp., Vol. 3, Session 4 Jul. 1967 4 p ref (See N69-12701 03-13)
Avail: CFSTI CSCL 04A

Satellite electron data were used to form correlations with auroral electrojet indices and with adiabatic changes due to ring currents. It was found that auroral electrojet activity always produced particle disturbances on L = 6 but not proportional to the auroral electrojet activity. G.G.

**N69-12718*#** Ballistic Research Labs., Aberdeen Proving Ground, Md.
**ROCKET MEASUREMENTS OF ELECTRON DENSITY, ELECTRON TEMPERATURE AND THE EARTH'S MAGNETIC FIELD ABOVE FORT CHURCHILL**
Harold T. Lootens Aug. 1968 62 p refs
(NASA Order R-82)
(NASA-CR-97948; AD-676109; BRL-1415) Avail: CFSTI CSCL 04A

The report describes the results obtained from two Nike-Apache and two Javelin (Argo D-4) rockets launched in mixed pairs at Fort Churchill, Canada, in November 1964. These rockets were instrumented with two-frequency propagation beacons, Langmuir probes, and proton precession magnetometers. The project objectives, vehicle and payload configurations, and field operations schedule are given. Electron density and electron temperature profiles, earth magnetic field measurements, and propagation beacon frequency stability values are presented. Author (TAB)

**N69-12724#** Technische Hochschule, Karlsruhe (West Germany). Geophysikalisches Inst.
**INVESTIGATIONS ON THE NONELASTIC BEHAVIOR OF THE UPPER MANTLE Final Scientific Report, 1 May 1965-30 Apr. 1968**
Sephan Mueller May 1968 80 p refs
(Contract AF 61(052)-661; ARPA Order 612-1)
(AD-676020; AFOSR-68-1932) Avail: CFSTI CSCL 8/11

The attenuation of seismic waves in the crust and upper mantle has been studied by various techniques in order to determine the specific quality factor Q. Anelastic deficiencies of the propagation medium can only be separated after corrections are made for the

effects of instrumental distortion, of the receiver crust and the source crust, the lossless propagation through the mantle and the source mechanism. Author (TAB)

**N69-12748#** Technische Hochschule, Aachen (West Germany). Forschungsstelle fuer Geophysik und Meteorologie.
**MEASUREMENTS OF THE THORON CONCENTRATION OF THE LOWER ATMOSPHERE IN RELATION TO THE EXCHANGE (AUSTAUSCH) IN THIS REGION Final Technical Report, May 1967–May 1968**
H. Israel, M. Horbert, and C. De la Riva Aug. 1968 285 p refs
(Contract DAJA37-67-C-0593)
(AD-676129; FTR-3) Avail: CFSTI CSCL 4/1

The report continues the studies on the thoron concentration in the lower atmosphere in connection with the vertical mass transfer in this region. As a brief introduction into the problems arising, the features of the natural radioactivity of the atmosphere are presented. Author (TAB)

**N69-12777*#** Hawaii Inst. of Geophysics, Honolulu.
**ON THE EQUILIBRIUM FIGURE OF THE EARTH**
Mohammad Asadullah Khan 18 Nov. 1968 42 p refs
(Grant NGR-12-001-045)
(NASA-CR-97887; HIG-68-10) Avail: CFSTI CSCL 08E

If de Sitter's hydrostatic equations are developed independent of the external potential theory, the hydrostatic geopotential coefficient $J_n$ occurs explicitly on the right-hand side of those equations. Since $J_n$ here has to be treated as an unknown in the solution, it becomes rather difficult to solve the equations independently, regardless of which of the dynamical parameters associated with the earth is taken as the initial datum. Solution is possible, however, with the help of a boundary condition derived from the external potential theory which neither assumes nor discounts the presence of equilibrium conditions in the earth's interior. If a general solution is constructed on this basis, the three particular solutions, usually quoted in literature, stem from it in the wake of the appropriate assumptions. Of course, the only meaningful solution—of these—is that corresponding to the polar moment of inertia as the initial datum. It is essential that the solution be constructed in this way in order to demonstrate clearly the correct structure of the problem of hydrostatic equilibrium. Author

**N69-12796#** Michigan Univ., Ann Arbor. Dept. of Meteorology and Oceanography.
**RAIN SCAVENGING STUDIES**
Dingle A. Nelson Aug. 1968 85 p refs
(Contract AT(11-1)-1407)
(COO-1407-20; PR-4) Avail: CFSTI

The scavenging of contaminants from the air by rain was studied with a view toward defining the physical processes that are most effective in cleaning the air of contamination. Three principle experiments were performed: the first used indium as a tracer to determine whether it is feasible to use tracer techniques in the study of circulation and rain scavenging processes. Indium was found to be useful for this purpose. A second series of experiments demonstrated the feasibility of using indium as a particulate tracer for cloud processes. Neutron activation was used for tracer detection. Finally, the artificial beta radioactivity in rainwater was measured along with rainfall rate to determine the physical processes which affect convective rains. NSA

**N69-12811** Brown Univ., Providence, R. I.
**WAVE PROPAGATION IN THE EARTH**
Kenneth Norman Sawyers (Ph.D. Thesis) 1967 94 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-1494

The problem of wave propagation is considered for three different self-gravitating elastic spheres. In the first the initial state of stress is radially symmetric and the sphere is transversely isotropic with respect to the radial direction at every point. In the second the state of stress is isotropic at every point, and the elastic properties are as in the first sphere. The third sphere corresponds to the usual isotropic Earth model used in seismology theory. The general solution for SH-type wave fronts is obtained for all three spheres and the results are compared from the point of view of applying seismographical T-$\Delta$ data to determine the variation of wave speed with depth. Dissert. Abstr.

**N69-12827#** Joint Publications Research Service, Washington, D. C.
**TERRESTRIAL GEOPHYSICS**
*In its* Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 192 20 Nov. 1968 p 80–102 refs (See N69-12823 03-34)
Avail: SOD/CFSTI

Abstracts of technical and scientific articles are presented on the following: (1) earthquake studies in the world during 1965, in various regions of the U.S.S.R., and in the Arctic; (2) studies of cyclic changes and component measurements in geomagnetism and pulsations; (3) properties and propagation of seismic waves; (4) gravitational convection in the earth's interior, and gravimetry on the Taman Peninsula; (5) upper mantle composition and magnetism, and geology of Moneron Island; (6) volcanic eruptions on Kamchatka; (7) geothermal features of the arctic Yenisei; and (8) effects of solar activities on $S_q$ variations. K.W.

**N69-12828#** Joint Publications Research Service, Washington, D. C.
**UPPER ATMOSPHERE AND SPACE RESEARCH**
*In its* Soviet-Bloc Res., in Geophys., Astronomy, and Space, No. 192 20 Nov. 1968 p 103–131 refs (See N69-12823 03-34)
Avail: SOD/CFSTI

News items and abstracts of scientific articles are presented concerning: (1) launching of Cosmos 248 and 249; (2) various spacecraft activities, including earth photography by Zond 5, electric rocket engine performance, low-thrust engine optimization and control, spacecraft light reflection, field strength computation for satellite communication, micrometeoroid measurements on Cosmos 135, Explorer 22 F layer studies, and lunar trajectory computations; (3) investigative techniques used in space research, including radiometry and neutron detection for cosmic rays, autocorrelation functions of meteor radio echoes, radio wave absorption and scattering measurements in the ionosphere, L $\alpha$ solar radiation scattering, and Venusian cloud layer estimation; (4) ionospheric studies, including geophysics of auroras, 11-year activity cycle and effects on $F_2$ critical frequency, layer thickness variations between E and F regions, ion formation in polar cap $F_2$ layer, electron density in E and F regions, reflections and limiting frequencies of the $E_s$ layer, and ionospheric research summary for the period 1957–1967; (5) other space-related studies, such as nighttime vertical motion and effects on radio wave field strength, magnetic nonuniformities in interplanetary space, polar storms and DR currents, motion stability of free systems, trapped-particle interaction with geomagnetic field, and frequency changes in micropulsations; and (6) three additional items on vibration-stimulated growth of mice and plants, Soviet-French space cooperation, and description of a life support model. K.W.

**N69-12829#** Illinois State Water Survey, Urbana.
**TRACING TROPOSPHERIC RADIOACTIVE DEBRIS BY ISENTROPIC TRAJECTORIES**
John W. Wilson and Parker T. Jones III Jul. 1968 36 p refs
(Contract AT(11-1)-1199)
(COO-1199-15; RR-3) Avail: CFSTI

Occasionally, large amounts of stratospheric radioactive debris are measured in surface rainwater. Two such situations have been subjected to isentropic trajectory analysis to determine if stratospheric air entered the troposphere as early as 36 hours prior to rainout of the radioactivity. Results of both cases indicated essentially no vertical mixing of upper- or mid-tropospheric air at any time within the period considered. A comparison between machine-computed and hand-produced trajectories was performed. It showed that the machine-produced trajectories were more accurate than either of two hand analysis methods. Author (NSA)

**N69-12832*#** TRW Systems Group, Redondo Beach, Calif. Space Sciences Lab.

**STUDY OF AN AURORAL ZONE ROCKET EXPERIMENT Final Report**

W. Bernstein, G. T. Inouye, N. L. Sanders, and R. L. Wax Oct. 1968 115 p refs

(Contracts NASw-698; NASw-1474)

(NASA-CR-97880; TRW-06484-6007-R0-00) Avail: CFSTI CSCL 04A

This report contains a description of the experimental payload of a Nike–Tomahawk sounding rocket, and an exposition of the scientific results derived from its launch into a breakup aurora from Ft. Churchill, Manitoba, Canada on April 25, 1968. Author

**N69-12884** Wisconsin Univ., Madison.

**AERIAL PHOTOGRAPHIC TECHNIQUES IN POLLUTION DETECTION**

James Phillip Scherz (Ph.D. Thesis) 1967 96 p

Avail: Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-12473

This thesis describes a research project dealing with recording images of water pollution by use of aerial photography. Reflection characteristics of various wastes and waters were first determined by use of a special attachment to a Spectrophotometer. Reflection curves of various aqueous solutions are included. These curves give percent energy reflected as a function of wavelength. Technical characteristics of various photographic films and filters are considered and various combinations were chosen for field testing. Aerial photographs were taken with a 35mm camera using different film filter combinations. Various types of water pollution were photographed and these were also correlated with the laboratory work. Types of water pollution considered include paper mill waste, municipal sewage, milk waste, and heat pollution. Photographic data is given for best photographing these various types of pollution. Also considered are best methods for photographing to depths in lake waters and for photographing the surface only. Dissert. Abstr.

**N69-12887** California Inst. of Tech., Pasadena.

**OXYGEN AND HYDROGEN ISOTOPE RATIOS IN SEDIMENTARY ROCKS AND MINERALS**

Samuel Marvin Savin (Ph.D. Thesis) 1967 228 p

Avail: Univ. Microfilms: HC $10.35/Microfilm $3.00 Order No. 67-17073

$O^{18}/O^{16}$ and D/H measurements were made on a variety of sedimentary rocks and minerals, with special emphasis on the fine-grained, predominantly clay mineral fraction of the sediments. Clay minerals which form under sedimentary conditions appear to form in isotopic equilibrium with their environments. Ocean sediments which are detrital in origin have isotopic compositions reflecting the fresh water origin of their clay minerals. There is no evidence for any isotopic exchange of detrital clay minerals with the marine environment in any of the ocean cores studied. (The sediments could be as old as 250,000 years as determined by ionium–thorium method.) The isotopic compositions of the clay minerals of ocean sediments are compatible with a weathering origin for a kaolinite and a metamorphic or diagenetic origin for chlorite. There is no evidence for any isotopic exchange of sandsized quartz or feldspar in the sedimentary environment, and these minerals may be used as indicators of provenance in sediments. Dissert. Abstr.

**N69-12899** Iowa Univ., Iowa City.

**INVESTIGATION OF ENERGETIC ELECTRON INTENSITIES IN THE EARTH'S OUTER RADIATION ZONE WITH OGO 1**

Howard Kent Hills (Ph.D. Thesis) 1967 117 p

Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 68-941

Intensities of outer zone electrons obtained with instrumentation borne on the earth-satellite OGO 1 are presented. Omnidirectional intensities near the magnetic equatorial plane are given for electrons of energy $E > 40$ keV, $E > 130$ keV, and $E > 2$ MeV, and are characterized by short-term variations superimposed upon an over-all long-term decrease. The pitch angle distributions of electrons ($E > 40$ keV and $E > 130$ keV) are approximated, and effects of geomagnetic storms upon the distribution of intensities of these electrons with energies above the detector thresholds are summarized. These results are compared with observations in order to distinguish between adiabatic and non-adiabatic particle behavior. Adiabatic motions are shown to be capable of causing large temporal variations in electron intensities during a magnetic storm. Dissert. Abstr.

**N69-12918*#** Reilly Translations, Los Angeles, Calif.

**MINERAL COMPOSITION OF ORES AND SILICAGEL QUALITY**

Masahiro Maeno 1968 10 p refs Transl. into ENGLISH from Kogyo Kogaku (Japan), v. 67, no. 9, 1964 p 1361–1364 Prepared for JPL

(Contract NAS7-100)

(NASA-CR-97881) Avail: CFSTI CSCL 08G

The acid clay of Nakajo and Odo deposits, their properties as ores, and the quality of the activated silica hydrogel obtained from them were measured and the relationship between the two investigated. One result is that the smaller the specific surface area of the acid clay ore, the larger the specific surface area of the activated silica hydrogel obtained from it. Furthermore, the greater the specific surface area of the activated silica hydrogel, the greater is its reinforcing properties for rubber. Results of chemical analysis, X-ray diffraction, differential thermal analysis, infrared spectroscopy, and the aromatic adsorption index show that acid clays with small specific surface areas, in comparison with those having large specific surface areas, have little cristoballite and a large amount of montmorillonite. Author

**N69-12983** Iowa Univ., Iowa City.

**SPECTRAL, SPATIAL, AND TEMPORAL VARIATIONS OBSERVED FOR OUTER ZONE ELECTRONS FROM 10 TO 100 keV WITH SATELLITE INJUN 3**

Theodore Allan Fritz (Ph.D. Thesis) 1967 202 p

Avail: Univ. Microfilms: HC $9.25/Microfilm $3.00 Order No. 68-928

Electrons with $E_e \geq 40$ keV were constantly observed precipitating into the atmosphere for all latitudes, $\Lambda \geq 45°$. At latitudes below the high latitude boundary, the flux of $\geq 40$ keV electrons in the loss cone was observed to always be $\sim 10^{-2}$ that of the locally mirroring flux. There was usually a spike of precipitating $\geq 40$ keV electrons at the high latitude boundary and the flux of $\geq 40$ keV electrons was usually observed to approach isotropy over the upper hemisphere at the position of the satellite at this boundary. Large intensities of electrons with energies not much greater than 40 keV were observed precipitating into the atmosphere for $\Lambda \geq 65°$ during magnetically quiet periods and the position of the high latitude outer zone boundary was observed to vary by $\Delta\Lambda \sim 7°$ while *no* magnetic activity was occurring. Dissert. Abstr.

N69-13068* Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**GEOPHYSICAL RESEARCH**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 37-43 (See N69-13060 03-34)
(Contract NAS12-436; Grants NGR-22-009-131; NGR-22-009-114)
Avail: CFSTI CSCL 04A

Experiments were made to determine the aerosol content of air from spectral analysis of laser echoes. Measurements were made of the density and temperature of electrons in a low-density reflex discharge by scattering of continuous-wave Ar + laser light. NSA

N69-13162# Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
**ON THE MEAN PATH OF BUOYANT BENT-OVER PLUMES UNDER VARIOUS ATMOSPHERIC STABILITY CONDITIONS**
P. R. Slawson Aug. 1968 92 p refs
(Contract AT(30-1)-3685)
(NYO-3685-14; RR-13) Avail: CFSTI

Careful photographic observations were made on the rise of smoke plumes from the Lakeview Generating Station, Ontario, in the spring of 1965 and 1967. Data relating to the stack variables were collected in some detail. Observations indicate that the dynamical problem of plume rise is very complex. This complexity is especially illustrated in the wavy appearance of plumes in unstable atmospheric conditions. The relatively simple theory presented correctly predicts (at least qualitatively) the complex observed plume paths and in so doing emphasizes the important physical factors required to adequately describe this path. It was found that the plume's own physical size and the atmospheric turbulence level had a more direct effect on plume behavior than the observed atmospheric temperature gradients, at least for distances from the source of a few thousand feet. In some cases where the plume bends over sharply very near the source the effect of the initial size and momentum of the plume may be important. Author (NSA)

N69-13249# Centre National de la Recherche Scientifique, Paris (France).
**ON THE ORIGIN OF ATMOSPHERIC METALS [SUR L'ORIGINE DES METAUX ATMOSPHERIQUES]**
J. Dufay (Observatories de Lyon) [1968] 8 p refs In FRENCH; ENGLISH summary Presented at I.A.G.A. Meeting, St. Gall, Switzerland, Sep. 1967 *Its* Publ. de l'Observatoire de Haute-Provence, Vol. 9, No. 35
Avail: CFSTI

Twilight observations of neutral ionized atmospheric metals are reviewed. Observations of calcium, lithium, potassium and sodium are discussed; relative abundances in the atmosphere, sea and meteorites are compared. The author concludes to the necessity of further investigations before the origin of atmospheric metals can be ascertained. Author

N69-13307#
**SCIENTIFIC RESULTS OF THE AUTOMATIC IONOSPHERE LABORATORY**
G. L. Grodzovskii [1968] 14 p refs Transl. into ENGLISH from a Russian paper Presented at the IAF Meeting, New York, Oct. 1968
Avail: CFSTI

The automatic ionosphere laboratory Iantar-1 with a gas plasma-ion engine was launched in October 1966 to 100-400 km altitudes with the aid of a geophysical rocket to study the prospects of controlled flight in the upper layers of the atmosphere. The telemetry obtained from the Iantar-1 on the functioning of the onboard systems and scientific instruments of the high altitude laboratory permitted investigation of the operating conditions of the gas electric jet engine in the ionosphere. Data on a scientific processing of the results of the conducted experiment are presented. Author

N69-13381# Air Force Cambridge Research Labs., Bedford, Mass.
**THE AURORAL OVAL AND THE SCINTILLATION BOUNDARY**
Jules Aarons, John P. Mullen, and Herbert E. Whitney Jul. 1968 18 p refs *Its* Environ. Res. Papers No. 289
(AD-676796; AFCRL-68-0380) Avail: CFSTI CSCL 4/1

The transition or boundary between high- and low-amplitude ionospheric fluctuations has been examined as a function of time. The boundary of the scintillation curtain reaches its lowest latitude (54 degrees geomagnetic north) between 1930 and 2230 local time. The most northerly boundary latitude of approximately 80 degrees Gn occurs during the 1030 to 1330 local standard time period. General agreement is demonstrated between observations of Transit IVA at 54 MHz at a subauroral site, Explorer 22 (S-66) at 40 MHz at three sites, and the main zone of discrete auroral events shown by other workers. Author (TAB)

N69-13388# Ohio State Univ., Columbus. Dept. of Geodetic Science.
**ON THE USE OF TERRAIN CORRECTION IN SOLVING MOLODENSKY'S PROBLEM**
Helmut Moritz May 1968 57 p refs
(Contract AF 19(628)-5701)
(AD-676302; AFCRL-68-0298; Rept.-108; SR-21) Avail: CFSTI CSCL 8/5

An approximate solution of Molodenskys boundary-value problem, provided by adding the terrain correction to the free-air anomaly and using this modified anomaly in Stokes and Vening Meinesz formulas, admits of a physical interpretation in terms of Helmerts condensation reduction. The detailed investigation of this topic gives an insight into the interrelation between Molodenskys theory and the conventional method of gravity reduction and into the nature of the linear correlation of the free-air anomalies with elevation. By-products of the investigation are: (1) that the usual Bouguer reduction of gravity does not give Bouguer anomalies in the strict sense, and (2) that a certain approximation, which is usually applied in practical solutions of Molodenskys problem, may lead into difficulties with respect to the deflection of the vertical. Author (TAB)

N69-13390# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
**THE DEEP STRUCTURE OF THE TERRITORY OF THE USSR [GLUBINNOE STROENIE TERRITORII SSSR]**
N. A. Belyaevskiy et al Jul. 1968 46 p refs Transl. into ENGLISH from Sov. Geol. (Moscow), no. 11, Nov. 1967 p 56-84
(AD-676492; ACIC-TC-1408) Avail: CFSTI CSCL 8/7

In order to clarify the regularities in the distribution of mineral resources, especially at depths, the development of problems of seismic activity and the solution of substantial problems in geology, it is necessary to study in detail the structure of the earths crust and the upper mantle, and the character and type of their current processes. Consequently, diverse aspects of geological, geochemical and especially geophysical investigations of the crustal stratum have been widely developed during the recent 10-15 years. At the same time, together with aeromagnetic and gravimetric surveys, by means of which almost the entire territory of the USSR has been covered, deep seismic investigations were carried out, which made it possible to characterize the structural features of the earths crust of many regions. These investigations were accomplished on 164 profiles for a distance of 52,600 km, including 31,000 km on land and more than 21,000 km at sea. Approximately 25,000 km of seismic profiles on land were carried out by the method of deep seismic sounding (DSS). Profile seismological surveys, investigations

from the stations Zemlya, and also other deep geophysical operations, in particular magnetotelluric soundings (MTS), have been recently used in conjunction with DSS for the study of the crustal structure. Author (TAB)

**N69-13409#** California Univ., Berkeley. Hydraulic Engineering Lab.
**DIFFRACTION OF WIND WAVES**
Shou-Shan Fan (Ph.D. Thesis) Aug. 1968 108 p refs
(Contract DACW72-68-C-0016)
(AD-676812; HEL-1-10) Avail: CFSTI CSCL 13/2

The purpose of this study is to seek a solution of the problem of the diffraction of wind waves by a breakwater. This study was divided into several parts. First, the conventional diffraction theories were examined in detail. Secondly, the characteristics of wind waves were briefly described. In order to justify the usefulness of either the data (experimental or field) or the method proposed, a digital computer simulation technique for obtaining the directional spectra of wind waves is introduced. The understanding of the directional spectrum is very important to the problem of wind waves, nearshore circulation, drift, wave force and wave forecasting, etc. The two methods - Fourier transformation and least square fittings recommended for computing the directional spectrum practically give no significant differences in their results, if a proper gage spacing is chosen. Author (TAB)

**N69-13452*#** California Univ., Berkeley. Space Sciences Lab.
**EVIDENCE THAT THE PLASMA SHEET IS THE SOURCE OF AURORAL ELECTRONS**
L. M. Chase 15 Aug. 1968 12 p refs Revised
(Grant NsG-05-003)
(NASA-CR-97933) Avail: CFSTI CSCL 04A

High resolution energy measurements of electrons and protons precipitating into the auroral zone made on three sounding rockets are described. The results are compared to measurements made by satellites in the geomagnetic tail. Evidence is presented indicating that the plasma sheet is the source of energetic electrons during auroral breakup. Author

**N69-13485#** Bhabha Atomic Research Centre, Bombay (India). Waste Treatment Div.
**HIGH EFFICIENCY AIR CLEANING AND FILTER TESTING**
A. A. Khan 1968 23 p
(BARC-347) Avail: CFSTI

Air cleaning in connection with air pollution control is discussed. The presentation is limited to aerosol removal. High efficiency filter applications are noted and the mechanisms of filtration are reviewed. Filter material characteristics are listed. Installation factors and filter test methods are presented. The economics of high efficiency filtration are considered. D.H.B.

**N69-13488#** Space Instruments Research, Inc., Atlanta, Ga.
**UPPER ATMOSPHERE WINDS FROM GUN LAUNCHED VERTICAL PROBES (BARBADOS, 21–22 JUN. 1967) (YUMA, 12 JUNE 1967) Final Report**
John Fagot Aug. 1968 64 p refs
(Contract DA-01-009-AMC-169(X))
(AD-676860) Avail: CFSTI CSCL 4/2

During the nights of 21-22 June 1967, two luminous trails were produced between 89 and 110km by the release of trimethyl aluminum from projectiles fired from a smoothbore sixteen-inch gun located on the West Indian island of Barbados (57.5 degrees W, 13.1 degrees N) and on the night of 12 June 1967 an additional trail was produced by a projectile fired from a similar sixteen-inch gun located at Yuma, Arizona (114.3 degrees W, 32.9 degrees N). These trails were photographed from neighboring sites and analyzed to yield wind profiles. This report contains the tabulated wind data from all three trails together with plots versus altitude of wind components, wind speed, and wind heading. Included in this report are ground plots of trails for all previous shots that had both an up trail and a down trail. Author (TAB)

**N69-13547#** Weapons Research Establishment, Salisbury (Australia).
**AUSTRALIAN SOUNDING ROCKET EXPERIMENTS, COMPLEMENTING SATELLITE FIRING**
Bryan Rofe and P. M. Twiss Jul. 1968 15 p refs Presented at U.N. Conf. on the Exploration and Peaceful Uses of Outer Space, Vienna, 14–27 Aug. 1968
(TM-SAD-184) Avail: CFSTI

In countries which have not developed a program of satellite firings there are a number of experiments which can be undertaken with sounding rockets, which may be mutually complementary to the measurements being made by satellites. By comparatively modest experiments, direct participation in space research can be undertaken. Australia has participated in several sounding rocket-satellite experiments, which are described. In 1962 a cloud survey immediately after a cold front passage involved the TIROS satellite, a sounding rocket, and aircraft and ground instrumentation. A further experiment in 1966 involved the measurement of solar ultra-violet and X-ray radiations from a LONG TOM sounding rocket at the time similar measurements were being made during a pass of the EXPLORER 30 satellite. The data obtained allowed a determination of the radiation incident upon the atmosphere and its absorption by molecular oxygen and ozone. A similar correlated satellite and sounding rocket experiment was conducted during the orbital life-time of the first Australian Satellite WRESAT launched from Woomera on 29 November, 1967. Author

**N69-13562#** State Univ. of New York, Stony Brook. Dept. of Earth and Space Sciences.
**$Th^{234}$ DISEQUILIBRIUM IN THE OCEAN**
Suman Bhat (Tata Inst. of Fundamental Res., Bombay), S. Krishnaswamy (Tata Inst. of Fundamental Res., Bombay), Rama (Tata Inst. of Fundamental Res., Bombay), and Willard S. Moore 1968 10 p Presented at Am. Geophys. Union Meeting, Apr. 1968
(Contract AT(30-1)-3629; Grant NSF GA-967)
(TID-24637) Avail: CFSTI

The spatial distribution of $^{234}Th$ is studied in the top 200 meter levels of coastal and open ocean waters. The value of the $^{234}Th/^{238}U$ activity ratio ranged from 0.2 to 1.4. This marked disequilibrium between $^{234}Th$ and its immediate parent demonstrates the possibility of using $^{234}Th$ as a tracer for studying rapid near-surface reactions associated with chemically active species in sea water. Any disequilibrium observed on the time scale of the 24 day half-life of $^{234}Th$ must be attributed to the gravitational settling of dust, biological materials, and inorganic precipitates present in sea water. Thus studies of $^{234}Th$ in surface waters are linked to the current rate of accumulation of sediments at the ocean floor. Author (NSA)

**N69-13568#** Kansas Univ., Lawrence. State Geological Survey.
**FORTRAN 4 CDC 6400 COMPUTER PROGRAM TO ANALYZE SUBSURFACE FOLD GEOMETRY**
E. H. Timothy Whitten and Daniel F. Merriam, ed. 1968 47 p refs *Its* Computer Contrib. 25
Avail: Issuing Activity

The FORTRAN IV program, prepared for the CDC 6400 computer, is designed principally to permit description and analysis of subsurface folds on the basis of well-log data if dip and strike information is not available. If dip data are available, these can be used directly by the program. Description of folds may be viewed as an end in itself. If folds in adjacent areas are described in terms of scalers, however, the areal variability may have distinct trends that permit limited extrapolation into neighboring unexplored areas.

In addition, if the folds are described in a quantitative manner, it is possible to correlate fold attributes with other geologic variables in an attempt to determine factors controlling development of differing fold geometry. Author

N69-13617# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
**COMBINED METHOD OF ADJUSTING A SPACE TRIANGULATION [KOMBINIROVANNII METOD URANIVANIYA KOSMICHESKOI TRIANGULYATSII]**
G. A. Ustinov Sep. 1968 10 p Transl. into ENGLISH from Geod. i Kartografiya (Moscow), no. 7, Jul. 1967 p 19–22
(AD-676494; ACIC-TC-1427) Avail: CFSTI CSCL 8/5

The method of closing surfaces is the most economical one for the adjustment of space triangulation. It is suitable for programming on the electric computers. However, it leads to a certain loss of adjustment accuracy, if the space triangulation contains observations made simultaneously at more than two stations for the observation of the artificial earth satellites. This translation is a study of the mathematical solution of the problem. TAB

N69-13638*# Michigan Univ., Ann Arbor.
**DIURNAL SURVEY OF THE THERMOSPHERE Final Report**
D. R. Taeusch, G. R. Carignan, A. F. Nagy, and H. B. Niemann Nov. 1968 145 p refs
(Contract NAS8-20232; ORA Proj. 07446)
(NASA-CR-61481) Avail: CFSTI CSCL 04A

The results of the launchings of eight Nike–Tomahawk sounding rocket payloads are summarized. The purpose of the payloads was to study the variability of the earth's atmospheric parameters in the altitude region between 120 and 350 km. The payloads each included an omegatron mass analyzer, an electron temperature probe, and an aspect determination system consisting principally of a lunar or a solar sensor. This complement of instruments permitted the determination of the molecular nitrogen density and temperature, the electron density and temperature, and the ion density in the altitude range of approximately 140 to 320 km over Cape Kennedy, Florida. Six of the payloads were launched for the purpose of establishing the diurnal variation of the thermosphere under relatively quiet solar activity levels. The additional two payloads were launched as a follow-on day–night pair to reestablish the maximum–minimum density and temperature values for this day. Author

N69-13637# International Institute for Aerial Survey and Earth Sciences, Delft (Netherlands).
**PRACTICAL APPLICATIONS OF AERIAL PHOTOGRAPHS IN FORESTRY AND OTHER VEGETATION STUDIES [APLICACIONES PRACTICAS DE LAS FOTOGRAFIAS AEREAS PARA LA SILVICULTURA Y OTROS ESTUDIOS DE VEGETACION**
D. A. Stellingwerf Mar. 1968 68 p refs In ENGLISH and SPANISH *Its* Ser. B, No. 46
Avail: CFSTI

The usefulness of aerial photography for forest management in the temperate zone is discussed. Examples of application are given, accompanied by photographs mounted for stereoscopic study. Although this report stresses the aspects of forest management, it also covers briefly cameras, film types and properties, mapping scales, observation and photographic techniques, and interpretation. K.W.

N69-13640# Bhabha Atomic Research Centre, Bombay (India).
**LOCATION OF EPICENTRE BY LEAST SQUARES AND PHASE VELOCITY STUDIES USING A SEISMIC ARRAY STATION**
B. S. Gopalakrishnan 1967 34 p refs
(BARC-321) Avail: CFSTI

Using the onset times of the P signal at some points of an array, the best least squares estimate of the azimuth and the velocity of the signal across the array is computed. The coordinates of the epicentre are then computed. The velocity structure of the earth can be deduced from the phase velocity epicentral distance relation. The object of this report is to discuss the method used to compute the phase velocity and azimuth of a seismic signal and the deductions that can be made from the computed results. Author

N69-13695*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
**GEODETIC RESEARCH STUDIES Final Technical Report**
E. M. Gaposchkin, C. A. Lundquist, and G. Veis Sep. 1968 73 p refs
(Contract NSR-09-015-054)
(NASA-CR-97907) Avail: CFSTI CSCL 08E

The usefulness of altimeter data was investigated as a means of measurement of the geopotential surface of the ocean for the purpose of extending the knowledge of the gravitation field of the earth. A procedure for the mutual improvement of accurate geoid and orbit measurements from altitude data is outlined. The suggested approach to altimetry adopts the assumption that sea level, averaged over wave structure, is an equipotential surface to an accuracy of approximately a meter. The appropriate formulas and solutions are included. The value of satellite-to-ocean altitudes for improving a description of the geopotential resides in the fact that sea level is much more sensitive to fine detail in the potential than is the satellite motion governed by the potential. B.P.

N69-13707# California Univ., Berkeley. Hydraulic Engineering Lab.
**DETERMINATION OF APPROXIMATE DIRECTIONAL SPECTRA FOR SURFACE WAVES**
Yoshimi Suzuki Aug. 1968 51 p refs
(Contract DACW72-68-C-0016)
(AD-676813; HEL-1-11) Avail: CFSTI CSCL 8/3

The knowledge of the two-dimensional spectra of surface waves is essential to the problem of the wave generating mechanism by winds, and to the related problem of wave forecasting. It is important to the understanding of coastal phenomena, and consequently to the design of coastal works. The author studied a method of determining the two-dimensional spectra of sea surface waves using the records of a pressure type wave recorder and the record of a special wave force meter which can record X and Y component wave force acting on a sphere in the sea. One set of data was analyzed by the method described, to obtain the approximate two-dimensional spectral density. In addition, the value of C sub D and C sub M in the conventional wave force formula for the sphere were obtained as a function of component wave frequency. Author (TAB)

N69-13729# Joint Publications Research Service, Washington, D. C.
**TERRESTRIAL GEOPHYSICS**
*In its* Soviet-Bloc Res. in Geophys., Astronomy, and Space 29 Nov. 1968 p 13–17 (See N69-13726 03-34)
Avail: CFSTI

Abstracts of scientific articles in terrestrial geophysics are presented. The use of $D_{st}$ variations in deep electromagnetic soundings was analyzed. Green's function was used to determine the earth's disturbing potential. A representation of the geomagnetic field at the earth's surface and in outer space was made using dipole models. The propagation of plane elastic waves in a medium with an arbitrary initial uniform stressed state was investigated assuming that the reaction of the medium to small disturbances is determined only by the tensor of initial stresses. The N-layer sphere in the field of a primary homogeneous plane wave was examined to

aid in characterizing the earth's deep structure by magnetotelluric methods. The dynamic characteristics of seismic waves determined from borehole observations were determined. The propagation of nonstationary electromagnetic fields in a conducting earth is discussed. B.P.

N69-13736# Bhabha Atomic Research Centre, Bombay (India). Waste Treatment Div.
**SORPTION OF RADIONUCLIDES BY ATTAPULGITE, MICA (INTERSTRATIFIED) AND VERMICULITE MINERALS**
Satya Brat, Umesh Chandra, A. R. Chinoy, and K. T. Thomas 1968 25 p refs
(BARC-349) Avail: CFSTI

Decontamination performance of some attapulgite, interstratified mica and vermiculite type clay minerals of Indian origin has been investigated and compared. Vermiculite, due to its high cation exchange capacity, stability in wide range of pH and its cheap availability was found practicable for treatment of radioactive liquid wastes containing fission products. Cesium selectivity of attapulgite, mica and vermiculite type clay minerals has been determined. The selectivities have been found to increase on heat treatment. The attainment of 10A structure does not seem to be necessary and the only criteria for the mineral to be cesium selective. Author

N69-13750# Technology, Inc., Dayton, Ohio.
**STUDY OF SOLUTION OF A LARGE SYSTEM OF LINEARIZED NORMAL EQUATIONS AND THE INVERSION OF THE ASSOCIATED COEFFICIENT MATRIX Final Technical Report, Feb. 1967–Apr. 1968**
Patrick D. Fliger, Jeannine M. Hilt, Richard S. Varga Apr. 1968 97 p refs
(Contract DAAK02-67-C-0236(x))
(AD-676849) Avail: CFSTI CSCL 8/2

Methods were studied to solve and invert the normalized coefficient matrices generated in analytical triangulation. These matrices are positive definite and each has three or five bands of non-zero entries by blocks. Each block of the matrix can be up to 600 x 600 in size. As a result of the study, block successive over-relaxation (BSOR) techniques were selected and incorporated in a computer program written in the Fortran IV language for the IBM 7094. This program can solve matrices up to 30,000 x 30,000. Besides a discussion of the BSOR techniques and a complete documentation of the computer program, the report describes alternate mathematical techniques. Author (TAB)

N69-13791# Northwestern Univ., Evanston, Ill. Dept. of Geology.
**FORTRAN 4 COMPUTER PROGRAM FOR SIMULATION OF TRANSGRESSION AND REGRESSION WITH CONTINUOUS-TIME MARKOV MODELS, PART 1**
William C. Krumbein Sep. 1968 43 p refs
(Contract Nonr-1228(36))
(AD-676505; TR-9-Pt-1) Avail: CFSTI CSCL 8/7

Continuous-time Markov models based on lateral movement of shallow marine and nonmarine environments during transgression and regression through continuous time can be adapted to a variety of lateral-shift processes, such as progressive facies changes across a sedimentary basin, onlap-offlap relations among stratigraphic rock bodies, etc. In this report a clastic-wedge model is used to generate equally spaced borehold or outcrop sections that show the type of deposits formed as the environments shift back and forth. The states of the transgressive-regressive system can be defined in terms of the position of the strandline through time, with the accumulating sediments representing responses to particular environments as they successively occupy a given monitoring station. Simulations are performed with a transition-rate matrix instead of the conventional transition-probability matrix, although the latter can also be adapted to lateral-shift processes. These two kinds of matrices can be transformed from one to another, and a computer program for this purpose is listed in this report. The main simulation program is illustrated with an experimental example, and the body of the text discusses some of the implications involved in structuring Markov models as continuous-time, discrete-state mechanisms. Author (TAB)

N69-13809# Ohio State Univ., Columbus. Dept. of Geodetic Science.
**SOLUTION OF THE GEODETIC BOUNDARY-VALUE PROBLEM IN CASE OF A REFERENCE ELLIPSOID**
Karl-Rudolf Koch Apr. 1968 42 p refs
(Contract AF 19(628)-5701)
(AD-676301; AFCRL-68-0158; DGS-104; SR-20) Avail: CFSTI CSCL 8/5

The solution of the boundary-value problem of physical geodesy in the case of a reference ellipsoid is given with a relative error of the order of the square of the flattening of the earth. The solution is obtained by representing the disturbing potential at the earths surface as the potential of a simple layer and by introducing this expression into the boundary condition. If the earths topography is neglected in the derived solution, a new solution of Stokes problem for a reference ellipsoid is obtained. As an example, the geodetic boundary-value problem is solved for a mathematical model of the earth. Author (TAB)

N69-13848# Institut Royal Météorologique de Belgique, Brussels. Inst. d'Hygiène et d'Epidémiologie.
**AIR POLLUTION: SMOKE AND $SO_2$ [POLLUTION ATMOSPHERIQUE: FUMEE ET $SO_2$] Monthly Bulletin, Feb. 1968**
1968 11 p in FRENCH and FLEMISH
Avail: CFSTI

Daily measurements made in February 1968 in the regions of Brabant, Liège, and Anvers of the air pollution are given in tabular form. Graphs of daily variations of smoke and $SO_2$ in the agglomerations of Liège and Anvers are also presented. ESRO

N69-13849# Institut Royal Météorologique de Belgique, Brussels. Inst. d'Hygiène et d'Epidémiologie.
**AIR POLLUTION: SMOKE AND $SO_2$ [POLLUTION ATMOSPHERIQUE: FUMEE ET $SO_2$] Monthly Bulletin, Jan. 1968**
1968 11 p in FRENCH and FLEMISH
Avail: CFSTI

Daily measurements made in January 1968 in the regions of Brabant, Liège, and Anvers of the air pollution are given in tabular form. Graphs of daily variations of smoke and $SO_2$ in the agglomerations of Liège and Anvers are also presented. ESRO

N69-13856# RAND Corp., Santa Monica, Calif.
**THREE WAYS TO TREAT THE IGRF ON THE EARTH'S SURFACE**
Anne B. Kahle Oct. 1968 9 p refs
(AD-676967; P-3955) Avail: CFSTI CSCL 8/14

When an International Geomagnetic Reference Field (IGRF) is adopted in the already agreed upon form based on geocentric coordinates, the problem will arise as to how to represent and use the IGRF on the Earths surface. The most straightforward and accurate method is to synthesize the values of the field, using the correction factors for the spheroidal shape of the earth. However, some workers may wish to avoid these correction factors, and use the geodetic coordinates directly. There would be two ways to do this. The first is to just ignore the differences in latitude and radius and use the field as if the earth were a sphere of constant radius. The second would be to use 3 different derived sets of coefficients for X, Y, and Z, each of which would accurately give the field value

of one element on the earths surface, but which would not be correct for the others. These three methods are examined here, to find how accurate each is, and how much work is involved in each.
Author (TAB)

N69-13897# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
**STRUCTURAL CHARACTERISTICS OF THE EARTH'S CRUST IN THE SOUTHERN PART OF THE EUROPEAN USSR [OSOBENNOSTI STROENIYA ZEMNOI KORY YUGA EVROPEISKOI CHASTI SSSR]**
A. V. Chekunov Aug. 1968 28 p refs Transl. into ENGLISH from Sov. Geologiya (USSR), v. 10, no. 12, 1967 p 13-29
(AD-676496; ACIC-TC-1411) Avail: CFSTI CSCL 8/7

As a result of deep seismic sounding methods, the deep structure of the earths crust of all the largest geological structures has been investigated in the southern part of the European USSR and in the Black Sea. These structures together with the structures located in the territory of the adjacent foreign countries form a rare combination of geotectonics elements which form a consecutive evolutional series. This translation is a study of the DSS findings, which lead to the assumption that the orthogonal and diagonal systems of abyssal fractures in the southern part of the European USSR, including the regions of the Paleozoic and Alpine folding have an old pre-Cambrian establishment. However, the abyssal fractures manifested actively during the Paleozoic or Meso-Cenozoic periods are probably regenerated old fractures. Crustal thicknesses are compared and basic geological structures and abyssal fractures are studied.
Author (TAB)

# 14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N69-12621 Ohio State Univ., Columbus.
**SIGNAL ENHANCEMENT BY COHERENT OPTICAL SPATIAL DIFFERENTIATION**
William Frank Haagen (Ph.D. Thesis) 1967 169 p
Avail: Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 68-2991

This investigation seeks to devise and examine an enhancing pre-processing filter for use in an optical spatial filtering apparatus. Among those considerations for a satisfactory design are the insertion loss of the filter and its relative performance for input signals of various sizes and orientations. Since the problem of enhancing the edges of photographic imagery is related to the general process of spatial differentiation, it was anticipated that any filter characteristic that proved satisfactory for edge enhancement has a mathematical description that can be related to a spatial derivative filter. The choice of a filter for the desired pre-processing effect is dictated by the form of its impulse response function, with the simplest function having the proper form in terms of the space coordinates x and y being $1/xy$. When a filter with an impulse response proportional to $1/xy$ is employed, its output is proportional to the two dimensional Hilbert transform of its input. Thus, the Hilbert transform is the connecting link relating edge enhancement to spatial differentiation.
Dissert. Abstr.

N69-12623 Arizona Univ., Tucson.
**THEORETICAL INVESTIGATION OF AN ELECTRON FILTER LENS**
Francis Joseph Campbell (Ph.D. Thesis) 1967 84 p
Avail: Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 67-11957

A theoretical design for an electrostatic filter lens is presented. The purpose of a filter lens is to improve contrast in the image by removing the inelastically scattered electrons from the beam of an electron microscope without impairing he resolution carried by the elastically scattered electrons. In particular, minimum chromatic field aberration and distortion is desirable. The filter lens is intended to replace the projector lens of an electron microscope having an accelerating potential of 6400 volts. An analytic potential along the axis was assumed and ray paths were calculated. The deviation at the image plane of a bundle of paraxial rays leaving the same object point but having different energies was used to determine the effect of axial chromatic aberration on resolution. By means of Laplace's equation and the analytic potential along the axis, the equipotential surfaces in space were determined.
Dissert. Abstr.

N69-12768 Rensselaer Polytechnic Inst., Troy, N. Y.
**MEASUREMENT OF TEMPERATURES DUE TO SLIDING IN ULTRA-HIGH VACUUM**
John Dimitrios Vasilakas (Ph.D. Thesis) 1967 95 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-849

An apparatus is designed and built for the measurement of temperatures due to friction near the interface of two sliding objects. The sliding specimen is electromagnetically suspended and rotated in the suspended position. The only elements in contact with the slider are the rider specimens which act not only as friction sources but also as bearings, guiding the rotating slider. Temperature probes in the slider are temperature sensitive resistors in a transmitter circuit. As their temperature changes, so does the frequency of transmission. In this way, temperatures are transmitted outside the system without introducing any additional contacts. Temperatures on the rider are measured with thermocouples. The normal force on the slider due to the rider and the total torque in the system are also measured. Temperatures are measured both in air and in vacuum.
Dissert. Abstr.

N69-12776 Illinois Univ., Urbana.
**LASER INTERFEROMETER MEASUREMENTS OF PARTICLE DENSITY PROFILES IN ELECTRIC SHOCK TUBES**
Carl Lawrence Gruber (Ph.D. Thesis) 1967 65 p
Avail: Univ. Microfilms: HC $3.60/Microfilm $3.00 Order No. 68-1760

This dissertation demonstrates the utility of the laser interferometer as a device for the measurement of particle density variations where the more conventional Mach-Zehnder system is not applicable. Moreover, it is shown that the separation of neutral and charged particle effects is more readily accomplished with the laser interferometer. Operating procedures are outlined and methods of data analysis are presented for the use of the laser interferometer in studies of shock fronts. This region of a shock wave is relatively inaccessible to other investigative techniques; therefore, the laser interferometer is well suited to measurements in low pressure shock tubes. Specific time variations of neutral and charged particle densities in the immediate vicinity of a shock front are given.
Dissert. Abstr.

N69-12908# California Univ., Berkeley. Lawrence Radiation Lab.
**VELOCITY SPECTROMETERS USED IN BEVATRON DEFLECTED BEAM RESEARCH**
George W. Edwards 30 Apr. 1968 6 p refs Presented at the 3rd Intern. Symp. on Discharges and Elec. Insulation in Vacuum, Paris, 16-18 Sep. 1968
(Contract W-7405-Eng-48)
(UCRL-18218; CONF-680916-1) Avail: CFSTI

Four glass cathode parallel-plate velocity spectrometers which have been used in secondary beam particle research are described. Two of these units have 10-foot-long and two have 15-foot-long electrodes. All units have 12-inch-wide electrodes. These units operate at up to 625 kV for many months without appreciable maintenance. On occasion the same unit has been used in several experiments with a total in use time of 6 to 8 months. Initial voltage conditioning is at $\sim 5 \times 10^{-6}$ torr. Above about 350 kV the vacuum is reduced to about 1 micron by a controlled argon leak into the chamber. Total conditioning time is usually less than 24 hours. About every 3 months a high-vacuum ($\sim c \times 10^{-6}$ torr) low-voltage reconditiong of about 6 hours is required. Current consumption, including power supply, is approximately $<150$ $\mu$A on each electrode ($<300$ $\mu$A total). Glass temperatures are maintained at about 105° C, thereby reducing volume resistivity to between $4 \times 10^8$ and $1.5 \times 19^{10}$ $\Omega$ cm. This evaluated temperature appears to retard the collection of hydrocarbons that can cause breakdown. Author (NSA)

**N69-12911#** Atomics International, Canoga Park, Calif.
**EVALUATION OF AN ELECTROCHEMICAL OXYGEN METER**
E. W. Murbach and N. W. Heath 30 Jun. 1968 24 p refs
(Contract AT(04-3)-701)
(AI-AEC-12700) Avail: CFSTI

Two electrochemical oxygen meter probes which have been operated in the Systems Quality Sodium Loop are described. Both electrodes were responsive to oxygen injections; however, due both to the interaction of stainless steel with oxygen and to the imprecision of analysis for oxygen below about 5 ppM in sodium, only qualitative results were obtained. The emf of the first electrode appeared to have a long term downward drift. The second electrode has been quite stable during five months of operation. The temperature coefficient of the second electrode is approximately zero. The apparent temperature coefficient of 0.5 mV/°F is a result of a shift in the equilibrium of the stainless steel-oxygen-sodium system. Author (NSA)

**N69-12957#** Istituto Superiore di Sanita, Rome (Italy). Lab. di Fisica.
**PARTICLE LOCALIZATION IN HIGHLY ABSORBING SCINTILLATORS**
G. Cortellessa 5 Jun. 1968 17 p refs
(ISS-68/18) Avail: CFSTI

This report deals with the possibility of localizing the position of a scintillation in a scintillator comparing the light output from different sides of the scintillator itself. The capabilities of the method are discussed for the scintillator NE 111 that has a particularly short absorption path. In a simplified case it is shown that it is possible to localize the scintillation with an error of few millimeters. Author

**N69-13046#** California Inst. of Tech., Pasadena. Synchrotron Lab.
**CALIBRATION OF THE 1200 MeV/c AND 1670 MeV/c MAGNET CONFIGURATIONS**
F. Wolverton 5 Mar. 1968 50 p refs
(Contract AT(11-1)-68)
(CALT-68-153; CTSL-36) Avail: CFSTI

The measurement of the focusing and acceptance properties and centrol momentum calibration of a magnetic proton spectrometer are described. The spectrometer will measure the moments of protons up to 1670 MeV/c. NSA

**N69-13063** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**ELECTRONIC INSTRUMENTATION**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 17-24 (See N69-13061 03-34)
(Grant NIH-1-505-FR-07047-01)
Avail: CFSTI

A theoretical study was made on the CEC 21-110 mass spectrometer to improve the resolution. A theoretical study of the spatial distribution of ions in the exit focal plane as a function of the spatial and velocity distributions of ions in the input focal plane was made. Preliminary results are given. NSA

**N69-13176*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**LIGHTING IN CRYOGENIC AND NONCRYOGENIC FLUIDS**
Robert C. Hendricks and Kenneth H. Baumeister Washington Dec. 1968 12 p refs Film Supplement Number C-260 to this report is available on loan from NASA, Lewis Research Center
(NASA-TM-X-1654) Avail: CFSTI CSCL 13A

An experimental study provided conditions for operating standard light bulbs that were submerged in ordinary and cryogenic fluids. Successful operation occurred whenever the light source came to thermal equilibrium with its environment. Author

**N69-13299#** Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
**USE OF WELL-TYPE IONIZATION CHAMBERS IN RADIOACTIVE METROLOGY [UTILISATION DES CHAMBRES D'IONISATION A PUITS EN METROLOGIE RADIOACTIVE]**
Jean Dalmazzone and Jean-Paul Guiho Mar. 1968 37 p refs In FRENCH
(CEA-R-3438) Avail: CFSTI

A summary is given of the results of observations and experiments gathered over a period of 10 years in the Radioelement Measurements Laboratory concerning the use of well-type chambers in refined metrology. The optimum conditions for obtaining good reproducibility are defined. This is indispensible if improved sensitivity and accuracy are required. The effects of the nature and the shape of the sources and of the contsiners, the random form of the response and its statistical treatment, and the nonlinearity and the show drift of the installation, are considered. A sound knowledge of the causes of error, the application of adequate correction methods and an exact calculation of the error, all make it possible to carry out measurements under the best conditions for obtaining a good reproducibility. The accuracy can attain 1.5 per cent. Author (NSA)

**N69-13311*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**A RADIOMETER FOR USE IN THERMAL STUDIES OF SPACECRAFT**
George E. Sweet and Howard B. Miller Washington Dec. 1968 36 p refs
(NASA-TN-D-4925) Avail: CFSTI CSCL 14B

A new disk radiometer that is essentially a modification of a loss measuring slug transducer has been designed for space vacuum-thermal environmental studies. The device is operable in vacuums less than $1.3 \times 10^{-3}$ N/m$^2$ at ambient temperature levels from 80° K to 450° K. Both steady state and time-varying total irradiances with magnitudes between 200 and 1500 W/m$^2$ can be measured with an error of about 10 percent. Once the radiometer is calibrated by using an extended black body reference source, it can be used in a variety of thermal study situations without recalibration. Because it is small in size (2.3-cm diameter by 0.5-cm height) and external cooling or constant temperature references are not required, it effects a minimal thermal disturbance to the test surface. The major feature of this radiometer is a shield which is located between the sensor and mounting surface. This shield is instrumented so that an empirical correction can be applied to the radiometer measurements to compensate for unwanted heat

transfer between the sensor and mounting surface. Criteria are presented for designing the sensor so that it will remain in temperature equilibrium with relevant heat sources and thus simplify data reduction. Example applications of the radiometer to a thermal control balloon model are also presented. Author

**N69-13397#** Centre National de la Recherche Scientifique, Marseilles (France). Lab. d'Astronomie Spatiale.
**ELECTRON TELESCOPES, CHAPTERS 1 TO 4 [TELESCOPIE ELECTRONIQUE]**
P. V. Shcheglov [1967] 68 p In FRENCH
Avail: CFSTI

Image converters and their modes of operation are described and their efficiencies computed. The various materials used for making cathodes are analyzed and their characteristics discussed. The cesium-oxygen cathodes are the only ones that can be used in the range 7,500-12,000 Å whereas polyalkaline ones can be used in the UV region. Simple image converters are of no interest in the visible region because of their very low gain. Amplification factors can be improved by using a cascade of image converters, and these are discussed in terms of their separate resolving powers. The resolving power of the electrostatic focussing device depends on the ratio of the initial energy of the electrons and the intensity of the field at the cathode. The effects of applying an external magnetic field as well as those of terrestrial and stray ones are also studied. The background noise originates in either the thermionic emission or the cold emission and the latter can be reduced by excess cesium on the photocathode. Different ways of fabricating cathodes are reviewed. Fluorescent tubes, image recording and the compromise that must be sought between high resolution and great efficiency are discussed. Tube construction is also considered and it is shown that remanent luminescence can be useful when the images are recorded by photography. ESRO

**N69-13398#** Centre National de la Recherche Scientifique, Marseilles (France). Lab. d'Astronomie Spatiale.
**ELECTRON TELESCOPES, CHAPTERS 5 TO 9 [TELESCOPIE ELECTRONIQUE]**
P. V. Shcheglov [1967] 84 p In FRENCH
Avail: CFSTI

The image can be transferred from the tube to photographic emulsions with an optical device or by direct contact and the efficiency and resolving power of both methods are discussed. The procedures and the equipment required for transfer by contact are also indicated. In this case it is necessary to eliminate remanent fluorescence on the tube by IR irradiation. The limit of observation of a telescope fitted with an image intensifier and photographic film are discussed in relation to the brightness of the sky background, the aperture of the telescope and the grain size of the emulsion. The effect of high atmospheric turbulence and the exposure time are also considered. The magnitude limit is shown as a function of local distance for various devices. Image intensifiers are often associated with spectroscopes and are most efficient in the IR region. The Fabry-Perot instrument is treated in detail. Lallemand electronic cameras are described and their efficiency is compared with standard ones. ESRO

**N69-13399#** Centre National de la Recherche Scientifique, Marseilles (France). Lab. d'Astronomie.
**ELECTRON TELESCOPES, CHAPTERS 10 TO 13 [TELESCOPIE ELECTRONIQUE]**
P. V. Shcheglov [1967] 77 p refs In FRENCH
Avail: CFSTI

Image converters can be used for photometric and spectrophotometric measurements and the linearity of such systems, their calibration and aberrations due to the heterogeneities of cathodes and tube are analyzed. The brightness of the tube depends on the accelerating voltage and the necessary high tension sources are considered. The different components of a telescope, particularly the refrigerator for the cathode, the corrections to the anode and the mounting of the photographic objectives are also discussed. Some results obtained with an electron telescope are presented. ESRO

**N69-13406#** Centre National de la Recherche Scientifique, Marseilles (France). Lab. d'Astronomie Spatiale.
**BALLOON-BORNE EXPERIMENT 'PERSEE' [EXPERIENCE 'PERSEE' BALLON]**
1967 19 p In FRENCH
Avail: CFSTI

The equipment included in the balloon-borne experiment 'Persee' is described. The aim of the experiment is to close the gap between rocket and ground measurements. It includes a spectrophotometer sensible to radiation between 2000 and 4700Å which will be aimed towards Andromeda galaxies. ESRO

**N69-13460#** Internationale Atomreaktorbau Gesellschaft, Bensberg (West Germany).
**STUDIES ON THE TECHNICAL FEASIBILITY AND CONDITIONS FOR THE CONSTRUCTION OF A GAMMA RADIATION DETECTOR FOR HIGH AMBIENT TEMPERATURES [UNTERSUCHUNG UBER DIE TECHNISCHEN MOGLICHKEITEN UND BEDINGUNGEN FUR DEN BAU EINES GAMMA-STRAHLEN-DETEKTORS FUR HOHE UMGEBUNGSTEMPERATUREN]**
K. Schmidt Brussels EURATOM Aug. 1968 37 p In GERMAN; ENGLISH summary
(Contract EURATOM-007-62-12 IRAD)
(EUR-4046.d) Avail: CFSTI

An investigation was conducted into the technical feasibility of and conditions for the construction of an ionization chamber with a $10^{-11}$ A/mr/hr sensitivity for a 500°C ambient temperature and theoretical consideration given to the question of the contribution of the electrode material and the filler gas to the ionization chamber current. The findings were that with soft gamma radiation the type of electrode material and filler gas have an influence on the magnitude of the current. Author

**N69-13464#** United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center.
**A CONTINUOUS ELECTROCHEMICAL METER FOR MEASUREMENT OF HYDROGEN IN SODIUM Progress Report, 1 Apr.–30 Jun. 1968**
31 Jul. 1968 32 p refs
(Contract AT(30-1)-3908)
(UNC-5223) Avail: CFSTI

Twelve experimental electrochemical hydrogen sensors were subjected to systematic gas tests in argon–hydrogen mixtures at temperatures ranging from 370 to 650°C, with encouraging results. It was found that the sensors did respond to hydrogen in conformance with a simple concentration cell model involving hydrogen transfer by hydride ion validating the sensor concept. Sensors having liquid electrolytes consisting of alkali hydrides dissolved in LiCl-KCl eutectic and gas reference electrodes operating with 5% hydrogen—95% argon exhibited near theoretical voltages at 370°C. Work on the sodium testing task was initiated. Author (NSA)

**N69-13477#** Naval Research Lab., Washington, D. C.
**SHOCK SIGNAL INTEGRATOR: DESCRIPTION, OPERATION, AND SCHEMATICS**
Marval W. Oleson Jul. 1968 70 p refs
(AD-676314; NRL-MR-1903) Avail: CFSTI CSCL 14/2

The Shock Signal Integrator was designed for the purpose of obtaining velocity and displacement integrals from acceleration transients of the type which characterize structural response to

impulsive loading. In addition to the basic integration function, the Shock Signal Integrator provides accessory functions for efficient transcription from a single parameter (acceleration) tape recording to a three parameter (acceleration, velocity, displacement) oscillographic format. Author (TAB)

**N69-13484#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**LOWERING THE ORDER OF EQUATIONS OF GYROSCOPIC SYSTEMS [O PONIZHENII PORYADKA URAVNENII GIROSKOPICHESKIKH SISTEM]**
I. V. Novozhilov Oct. 1967 17 p refs Transl. into ENGLISH from Tr. Vses. S'ezda Teor. Prikl. Mekh. 2nd (Moscow), no. 5, 1966 p 33–39
(AD-676542; FTD-MT-24-267-67) Avail: CFSTI CSCL 20/11

The possibility of reducing the order of gyroscopic equations is discussed. This is achieved by using a differential equation with a small parameter in its leading derivative. For a steady holonomic system the governing equation of motion for the gyroscope system is reduced by using the small parameter assumption mu = lambda squared. Physically, this is equivalent to assuming the high frequency components of the motion to have a small period compared with its precession period. Two examples are given to illustrate the method. The first deals with the motion of a holonomic and scleronomic system under gyroscopic and dissipative forces. The second is the motion of a gyroscope with a universal joint of finite rigidity. TAB

**N69-13491#** Stanford Univ., Calif. High Energy Physics Lab.
**RESPONSE OF LITHIUM-DRIFTED SILICON RADIATION DETECTORS TO HIGH ENERGY CHARGED PARTICLES**
D. W. Aitken, D. W. Emerson, and H. R. Zulliger [1968] 21 p refs
(Contracts AF 49(638)-1593; Nonr-225(67))
(AD-676699; AFOSR-68-1675) Avail: CFSTI CSCL 18/4

The measured response characteristics of lithium drifted silicon radiation detectors at 295 deg. K and 79 deg. K are presented for protons with energies from 31.5 to 350 MeV; for positive pions with energies from 50.2 to 206 MeV; and for electrons with energies from 265 keV to 767.2 MeV. Analysis of the energy loss spectra confirms that the energy is being deposited by the protons and pions in the silicon purely through collision losses, whereas it appears that the silicon absorbs additional energy lost by the high energy electrons through interaction of the bremsstrahlung radiation in the depletion region. The charge collection efficiency determined by gamma rays is shown to agree with the charge collection efficiency determined by minimum ionizing particles. Nonlinear effects caused by unequal electron and hole trapping lengths and surface effects lead to reduced charge collection efficiencies for low energy electrons which do not completely penetrate the detector depletion region, in agreement with theory and with observations in the x-ray region. Apparent recombination effects also lead to reduced charge collection efficiencies at low field or for protons with energies below about 100 MeV under constant bias conditions. The present data support the conclusion that the charge conversion factor at any one temperature is constant to within 1% for electrons, pions and protons over the entire energy span measured. Author (TAB)

**N69-13513#** Centre National de la Recherche Scientifique, Marseilles (France). Lab. d'Astronomie Spatiale.
**SPACE EXPERIMENTS**
Oct. 1967 40 p
(Rept-67-TECH-04) Avail: CFSTI

A description of the following space equipment is made: a Lyman alpha spectrophotometer of the O.S.O. satellite; a monochromator mounted on POGO to study the red lines of the night sky; a simple camera to obtain photographs of the diurnal sky; two ultraviolet cameras designed to study the night sky; Perseus, two spectrophotometers to investigate the limits of the Andromeda galaxy; a CEPHEE astronomical design to study the optical ultraviolet spectrum of small galactic objects, and Minisis-Isis designed to study the remote corona of the sun. ESRO

**N69-13612#** Army Electronics Labs., Fort Monmouth, N. J.
**NEWLY DEVELOPED CRYSTAL MEASUREMENT INSTRUMENTS**
Owen P. Layden, Arthur D. Ballato, and Charles L. Shible Aug. 1968 21 p refs
(AD-676815; ECOM-3015) Avail: CFSTI CSCL 14/2

This report is concerned with two crystal measurement instruments that have recently been developed. The first of these instruments is the Crystal Impedance (C.I.) Meter System covering the frequency range .8 to 20 MHz developed by Piezo Technology, Inc. This instrument is an outgrowth of the C. I. Meter, which has been in use for years, and it uses the C. I. Meter oscillator circuit as the heart of the instrument. The system is made up of several components, but the basic operation is based on a resistance substitution in the oscillator circuit. The other instrument is the Servo Bridge System covering the frequency range .8 to 200 MHz developed by Parzen Research Inc. This instrument provides a signal source to feed a bridge, which contains the crystal. It also includes a narrow band detector and a feedback network so that the signal source can be locked to the crystal frequency. The report describes both systems by simplified block diagrams and gives measurement results showing capabilities of the instruments. Author (TAB)

**N69-13618#** Cambridge Systems Inc., Newton, Mass.
**IMPROVEMENTS AND REFINEMENTS ON A PULSE TYPE SONIC ANEMOMETER Final Report, 18 Jun. 1966–31 Jul. 1968**
Arthur Bisberg, Arthur Pappas, and David J. Beaubien Aug. 1968 59 p refs
(Contract AF 19(628)-6049)
(AD-676305; AFCRL-68-0416) Avail: CFSTI CSCL 4/2

The report describes a series of improvements and refinements which have been applied to the pulse-type sonic anemometer. It is essential that the reader review the Final Report, Design Development and Testing of an Acoustic Anemometer, AFCRL Report No. 66-650, to this previous development activity as background for the material presented in this document. The refinements include the introduction of time series multiplexing techniques to permit 15,000 foot separation between the transducer array and the readout site, the introduction of integrated circuits, certain improvements in the array and transducer design, array de-icing techniques and a variety of other minor improvements. A complete discussion of the engineering criteria supporting the refinements, together with a description of the improved system is given. Author (TAB)

**N69-13666#** California Univ., Berkeley. Lawrence Radiation Lab.
**LOW TEMPERATURE STAGE FOR THE PICKER THETA–THETA X-RAY DIFFRACTOMETER**
Eckhard Nembach Aug. 1968 10 p ref
(Contract W-7405-ENG-48)
(UCRL-18410) Avail: CFSTI

A cold stage for the Picker Theta–Theta X-ray Diffractometer, Model 3488K, was constructed to measure lattice constants of powder specimens at 91°K. Author (NSA)

**N69-13673#** Aerospace Research Labs., Wright-Patterson AFB, Ohio.
**PHOTOGRAPHIC RECORDINGS WITH ENHANCED CONTRAST USING THE STORAGE IMAGE AMPLIFIER, AND APPLICATIONS IN RESEARCH Final Report**

Radames K. H. Gebel, Daniel Charles, Georg Wendt, and Hermann R. Mestwerdt May 1968 12 p
(AD-676267; ARL-68-0100) Avail: CFSTI CSCL 14/5

When photographing low-contrast scenes with uneven background, films can be processed for optimum contrast only at 1 selected brightness and considerable information in other brightness levels is lost. Taking several pictures of the same scene and optimizing the contrast at different levels, does not solve the problem due to the nonlinear film response. Exposures taken at the toe of the H and D curve would not result in usable densities or, if taken at the straightline portion, the contrast rendition is not sufficient and the problem cannot be solved with film alone. A solution is the application of the storage image amplifier in which scenes, once stored, may be subsequently reproduced several times on the phosphor screen with different brightness and contrast rendition by changing electrode voltages. Assuming for film transport 0.15 sec per frame, each scene yields 10 pictures, with new scenes every 2 sec. A recently developed simultaneous storage image amplifier shows contrast rendition achieved so far only with the sequential image amplifier. Further, the storage screen acts as limiter preventing halation caused by strong point sources occurring in conventional devices. Applications in physics research and typical photographs with different contrast rendition are shown.
Author (TAB)

**N69-13710#** Oak Ridge National Lab., Tenn.
**GAMMA-RAY RESPONSE OF THE NE-213 LIQUID SCINTILLATION DETECTOR**
C. Y. Fu, V. R. Cain, E. A. Straker, P. N. Stevens, and F. J. Muckenthaler 1 Aug. 1968 47 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2273) Avail: CFSTI

The response of an NE-213 scintillation counter to gamma rays has been calculated with the OGRE-G Monte Carlo gamma-ray transport code modified to include the transport of Compton electrons. Since the calculation model did not explicitly include statistical fluctuations due to variations in the intensity of light produced by the scintillator, nonuniformities in the transmission of the light pulse to the photomultiplier, nonlinearities in the conversion of the light pulse into an electrical pulse by the photomultiplier, and variation in the amplification of the pulse, the application of two correction factors to the Monte Carlo results was required. The resulting calculated responses were in excellent agreement with experimental data. Comparisons of the calculated responses with experimental data are presented for gamma-ray source energies from 0.66 to 6.13 MeV.
Author (NSA)

**N69-13725#** Harry Diamond Labs., Washington, D. C.
**RADIATION-HARDENED VOLTAGE-CONTROLLED OSCILLATORS AND TAPE HEAD DRIVERS**
John W. Utecht Jul. 1968 22 p
(AD-676821; HDL-TR-1353) Avail: CFSTI CSCL 14/3

A radiation-hardened magnetic tape recorder system was developed and designed into a package suitable for field use to record data in the presence of high intensity nuclear radiation. Performance of the system was evaluated in representative environments produced by a Triga Mark F pulse generator and by Flash X-rays. At gamma dose rates of 5 x 10 to the 8th power R/sec, a change in bandwidth of less than 10 percent occurred for about 1 microsec. A permanent change of approximately 1 percent in the resting frequency of the VCO2 was incurred from exposure to a neutron fluence of 5 x 10 to the 13th power N/sq cm (Pu).
Author (TAB)

**N69-13734#** Human Factors Research, Inc., Santa Barbara, Calif.
**STUDIES OF THE ELASTIC SURFACE TRANSFORMATION PROCESS**
Robert J. Hall, William F. Dossett, Gene R. Kelley, and William D. Dods Aug. 1968 34 p refs
(Contract N00014-67-C-0312)
(AD-676631; TR-775-1) Avail: CFSTI CSCL 5/8

The report presents the current status of the Elastic Surface Transformation Process and of the mathematical model pertaining to it. Materials and equipment are reviewed and the development of an elastic emulsion is discussed. Illustrative examples of EST-processed images showing improvements attained in contrast and edge definition are included. A quantitative theory relating element modulation and information transmission is discussed, and certain extensions and refinements to the model are presented.
Author (TAB)

**N69-13749#** Michigan Univ., Ann Arbor. Dept. of Physics.
**THE USE OF IONIZATION CALORIMETERS IN HIGH ENERGY NEUTRON EXPERIMENTS AT PARTICLE ACCELERATORS**
Lawrence W. Jones Jul. 1968 22 p refs Presented at the Intern. Symp. on Nucl. Electron., Versailles, France
(Contract Nonr-1224(23))
(AD-676909; REPT-03106-32-T; TR-32) Avail: CFSTI CSCL 18/4

Ionization calorimeters, or total absorption spectrometers, have enjoyed widespread use by cosmic ray physicists as energy-sensitive detectors for hadron events. We have successfully employed similar detectors of smaller scale in experiments on neutron total cross sections at particle accelerators. A description of these detectors and a discussion of other applications is presented.
Author (TAB)

**N69-13796#** Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.
**DETECTION OF FISSION PRODUCTS IN CARBON DIOXIDE BY INSTANTANEOUS ION COLLECTION [DETECTION DE PRODUITS DE FISSION DANS DU GAZ CARBONIQUE PAR COLLECTION SPONTANEE D'IONS]**
Roger Le Meur and André Lorin Apr. 1968 37 p refs In FRENCH; ENGLISH summary
(CEA-R-3511) Avail: CFSTI

This report describes a fission product detector with instantaneous electric collection, capable of analyzing carbon dioxide up to a pressure of 60 bars and at a temperature of 200°C. In contrast to delayed collection detectors, this apparatus makes it possible to collect rubidium and cesium ions as soon as they are formed; this avoids losses due to recombination. The detector has been tested with a fission product source made up of a uranium oxide sample bombarded by a neutron flux. The activity of the ions collected as a function of an electric field has been measured for different parameters: pressure, temperature, $CO_2$ gas flow rate, and the volume of the ion-formation chamber. The sensitivity of this apparatus is compared to that of other fission product detectors. For a low volume-flow rate, e.g. 100 $cm^3$ $sec^{-1}$, its sensitivity for krypton 88 is better than that of a delayed collection detector. An apparatus of this type could be used as a burst can detector on a reactor with a large number of channels, with a low gas sampling rate per channel. The equipment will be included in the burst can detector installations in the FESSENHEIM reactor.
Author (ESRO)

**N69-13798#** Commissariat à l'Energie Atomique, Bruyères-le-Châtel (France).
**DEVELOPMENT OF A GAS-IONIZATION $\beta$-SPECTROMETER [ETUDE ET REALISATION D'UN SPECTROMETRE $\beta$ A IONISATION GAZEUSE]**
René Le Du (Ph.D. Thesis--C.N.A.M., 1965) May 1968 123 p refs In FRENCH; ENGLISH summary
(CEA-R-3293) Avail: CFSTI

A $\beta$-spectrometer is being developed which has two main objectives: the determination of the nature and the degree of purity of certain $\beta$-emitting radio active substances and the study of an activity calibration process for $\beta$-emitting radioactive sources.
Author (ESRO)

**N69-13817#** Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.
**VARIABLE TIME-CONSTANT FREQUENCY METER WITH MECL INTEGRATED CIRCUITS [FREQUENCEMETRE NUMERIQUE A CONSTANTES DE TEMPS VARIABLES ET EN CIRCUITS INTEGRES MECL]**
Jacques Fuan and Josef Kaiser Apr. 1968 37 p In FRENCH; ENGLISH summary
(CEA-R-3507) Avail: CFSTI

The principal characteristic of this frequency meter is that its accuracy is fixed in advance for the whole frequency range which is to be measured. For this, it is possible to change the measurement range several times by changing the time constant which varies over discrete values and adopts that corresponding to the measured frequency for a given accuracy. The frequency meter presented here gives three values of the accuracy, i.e. three groups of variable time constants, and operates as a chronometer and as a conventional frequency meter. The aim is to describe the construction of a variable time-constant system and it is obvious that further work would lead, because of new industrial circuits, to great improvements in the design of the apparatus.
Author (ESRO)

**N69-13829#** Oak Ridge National Lab., Tenn.
**TRIPLE-AXIS NEUTRON SPECTROMETER-COMPUTER INTERFACE**
E. Madden, J. W. Reynolds, and S. P. King 24 Jul. 1968 65 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2246) Avail: CFSTI

An interface was constructed so that a PDP-8 computer can be used to control the experimental apparatus and data acquisition devices for a triple-axis neutron spectrometer. Up to eight Slo-Syn stepping motors can be positioned. The count rates of the primary neutron beam (before it passes through the monochromator), the incident neutron beam (after it passes through the monochromator), and the diffracted neutron beam are measured, and the adjusted intensity measurements of the diffracted beam are recorded as a histogram plot. The design and construction of the interface system, the input and output circuits, interface operation requirements, motor test and photomaker set-up procedures, and other details are summarized.
NSA

**N69-13837#** Mast Development Co., Davenport, Iowa.
**OZONESONDE, BUBBLER TYPE Final Report, 25 Sep. 1967–31 Jul. 1968**
James I. Mueller 31 Jul. 1968 27 p
(Contract F19628-68-C-0092)
(AD-676780; AFCRL-68-0409) Avail: CFSTI CSCL 14/2

The Mast Model 730-7 Series Ozonesonde continuously measures ozone concentrations by an electro chemical reaction while it is balloon borne and transmits the information to a ground station by means of the AN/AMT/4B, AN/AMT-12, or ESSA radiosondes. Tests and flight experience indicate that all components of the ozonesonde are adequate to accomplish the task required without any modification of the radiosondes. A switching device provides a continuing cycle of 3 seconds of ozone data and 7 seconds of meteorological data. At 2 1/2 minute intervals, the switch selects alternately between air pump temperature data and a calibration function.
Author (TAB)

**N69-13854#** Air Force Cambridge Research Labs., Bedford, Mass.
**A SYSTEM TO PERFORM REAL-TIME FOURIER SPECTROSCOPY**
Joseph E. Hoffman, Jr. Aug. 1968 131 p refs *Its* Instrumentation Papers No. 146
(AD-676969; AFCRL-68-0401) Avail: CFSTI CSCL 20/6

A real-time system to perform Fourier spectroscopy is described. The spectral distribution is synthesized by the successive summation of cosine functions with amplitudes and frequencies which are determined by the sample points of the interferogram. Summation of these cosine functions is performed in a digital memory oscilloscope which has 1024 addresses. The design criteria and the principles of operation of the system are discussed in detail. Sources of error are examined and several methods of error reduction are discussed. The limitations of this type of system are described and improvements are recommended. Experimental data are presented and the performance of the real-time system is compared to that of a special purpose analog computer, and a digital computer.
Author (TAB)

**N69-13884#** Centre National de la Recherche Scientifique, Marseilles (France). Lab. d'Astronomie Spatiale.
**PROGRAM OF EXPERIMENT 'PERSEE' [PROGRAMME DE L'EXPERIENCE 'PERSEE']**
G. Courtes 1967 26 p In FRENCH
Avail: CFSTI

The experiment 'Persée', to be launched on a Veronique rocket, is intended to gain pictures of the Andromeda galaxy in the 1216Å, 2000Å, 2800Å and 3600Å bands, and to investigate the limits of the galaxy. The optical equipment and the telemetry system are described. Suitable launch windows during the period November 1966 - January 1967 are computed.
ESRO

**N69-13892** European Organization for Nuclear Research, Geneva (Switzerland). Nuclear Physics Apparatus Div.
**DOLL—THE ON-LINE MEASUREMENT SYSTEM FOR HEAVY LIQUID BUBBLE CHAMBER PHOTOGRAPHS**
K. Soop 18 Oct. 1968 111 p refs
(CERN-68-37) Avail: Issuing Activity

DOLL (Decoding On-Line Logic) is a real-time data processing system for the on-line measurement of bubble chamber photographs. This manual contains system configuration and basic notions, the measurement logic, DOLL processing principles, measurement format, geometry, operation, program setup, off-line procedures, and a detailed description of all information on hardware and methods related to the system. The DOLL system utilizes a CDC 3100 computer. In addition to the on-line input-output connection, DOLL uses the following minimum of peripheral equipment: a console typewriter, a disk storage capable of holding at least 200 K computer words (for program and data overlay), and one magnetic tape drive for event output. Depending on the requirements of the experiments and a large number of options and facilities, efficient use can also be made of a card reader, a second magnetic tape drive, and a paper tape punch.
K.W.

# 15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

**N69-12858** Texas Technological Coll., Lubbock.
**AN ANALYSIS OF THE RELIABILITY OF TOOL LIFE PREDICTION**
Brian K. Lambert (Ph.D. Thesis) 1967 164 p
Avail: Univ. Microfilms: HC $7.60/Microfilm $3.00 Order No. 68-2617

This research was primarily concerned with investigating the reliability of present methods of tool life evaluation and prediction. The study included an analysis of the variability of certain tool life parameters and the effects of this variability on an economic model designed to predict the cutting speed for minimum production cost. Also included in this investigation was an analysis of the reliability of thrust force measurements as an indicator of tool wear. In addition, the flank wear resulting from an intermittent cutting operation and the wear occurring in a continuous cutting process were compared. Dissert. Abstr.

**N69-12788** Rensselaer Polytechnic Inst., Troy, N. Y.
**EFFECTS OF SURFACE ROUGHNESS ON HYDRODYNAMIC FILM LUBRICATION**
Shang-Tung Tzeng (Ph.D. Thesis) 1967 71 p
Avail: Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 68-848

Effects of surface roughness on important parameters such as load carrying capacity and frictional forces in hydrodynamic film lubrication are studied. The distinction is made between waviness and roughness, the latter being treated as a random quantity which may be characterized by a probability density function, determined experimentally. The roughness, usually considered as of approximately Gaussian distribution is shown to be equally well represented by a Beta distribution with certain advantages over the Gaussian distribution. The roughness is considered to be of order of magnitude of mean film thickness itself. Theory of stochastic processes has been applied and methods of solutions associated with the problems have been fully developed. Closed form solutions have been obtained for slider bearings and journal bearings. The analysis allows quantitative as well as qualitative evaluation of the effects. Numerical examples are shown for each case. Dissert. Abstr.

**N69-12818#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ADVANCES IN THE THEORY OF FRICTION (SELECTED ARTICLES)**
4 Dec. 1967 28 p refs Transl. into ENGLISH from the book "Novoye V Teorii Treniya" Moscow, Nauka, 1966 p 83-90; 173-178
(AD-675565; FTD-HT-23-899-67) Avail: CFSTI CSCL 20/11

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1. SOME CHARACTERISTICS OF FRICTION AND WEAR OF MATERIALS AT HIGH SLIP SPEEDS V. A. Balakin p 1-12 (See N69-12819 03-15)

2. ANTISCORING PROPERTIES OF PHOSPHATED RUBBING SURFACES COATED WITH SOLID LUBRICANT B. P. Artem'yev p 13-21 refs (See N69-12820 03-15)

**N69-12819#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SOME CHARACTERISTICS OF FRICTION AND WEAR OF MATERIALS AT HIGH SLIP SPEEDS**
V. A. Balakin *In its* Advances in the Theory of Friction 4 Dec. 1967 p 1-12 (See N69-12818 03-15)
Avail: CFSTI

The coefficient of friction depends on the following factors: the material and the state of the contact surfaces; the construction of the friction joint or unit; and the operating conditions (the sliding velocity; the specific load; the temperature; and the temperature gradient in the contact zone). The article considers the motion of a real point of mass m, which is subjected to the action of a constant vertical load over an absolutely rigid wavy sinusoidal surface, for which the wavelength is significantly larger than the amplitude. This is valid for a real body for which the linear dimension is substantially less than the wavelength. On the above basis, the author develops mathematically four possible cases. It is demonstrated that in determination of the friction coefficient and the wear of materials at high sliding velocities, it is necessary to take into account unsteady state friction processes caused by the presence of factors such as undulations and variations in form. Author

**N69-12820#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ANTISCORING PROPERTIES OF PHOSPHATED RUBBING SURFACES COATED WITH SOLID LUBRICANT**
B. P. Artem'yev *In its* Advances in the Theory of Friction 4 Dec. 1967 p 13-21 refs (See N69-12818 03-15)
Avail: CFSTI

A lubricant based on molybdenum disulfide is widely used in industry. To determine the anti-wear and anti-seizing properties of such a lubricant, tests were carried out in a four-sphere machine. The tests were made at a constant rotational speed of the upper sphere equal to 1420 rev/min. The load was gradually increased during the tests. The following conclusions were drawn: 1) the protective properties of solid molybdenum lubricant are apparent to a greater degree in the high pressure region; 2) the excellent antiseizing properties of solid molybdenum lubricants can be explained not only by the laminar structure of its crystal lattice, but by the increase in the bearing surface which results in a decrease of the specific pressure on the contact surfaces; 3) roughness of the surface, produced by parkerizing, has a positive effect on the work of the applied films, at corresponding particle sizes of the molybdenum disulfide; 4) solid molybdenum lubricants are to be recommended for use in high load friction units. Author

**N69-12897#** Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
**AN IN SITU WELD DEFECT DETECTOR ACOUSTIC EMISSION**
W. D. Jolly Sep. 1968 28 p refs
(Contract AT(45-1)-1830)
(BNWL-817) Avail: CFSTI

The application of acoustic emission to the detection of weld defects during and immediately following the welding operation is described. Both manual and machine welds fabricated by the gas tungsten-arc process produce acoustic emission. Acoustic emission from welds in 304L and 316 SS is examined in detail. A correlation is made between acoustic emission rate and radiographic analysis data. A relationship between acoustic emission rate and weld defect region temperature is demonstrated. Acoustic emission pulse characteristics and spectral power distribution are presented. Problems involved in locating weld defects by means of acoustic emission signals are discussed. Author (NSA)

**N69-12968*#** Chrysler Corp., New Orleans, La. Space Div.
**TEST REPORT FOR GROVE VALVE AND REGULATOR COMPANY PART NO. T-1538 AND T-1541 PRESSURE REGULATORS**
L. Clarkson 10 Jun. 1968 148 p
(Contract NAS8-4016)
(NASA-CR-97873; TR-RE-CCSD-FO-1020-3-REV-A) Avail: CFSTI CSCL 13K

Results are presented of tests performed on one specimen of Pressure Regulator B75M50305-1, and two specimens of B75M50305-4. The specimens differ only in orifice size. The

B75M50305-1, has a 3/8-inch orifice rating and the B75M50305-4 has a 1-inch. Tests, originally, were begun on four specimens. These tests resulted in a permanent damage to one specimen during the proof pressure test and also serious external leakage to the other three specimens. Consequently, the vendor modified the three undamaged specimens with redesigned dome plates and body plugs. The three modified specimens were then subjected to a complete test program. The following tests were performed: receiving inspection, proof pressure, functional, prolonged pressure, low temperature, high temperature, flow and regulator setting surge, salt fog, vibration, life cycle, final inspection, and burst. The performance of the three specimens was generally in accordance with the specification requirements. Author

**N69-13031*#** Chrysler Corp., New Orleans, La. Space Div.
**MANUAL GLOBE VALVE, 3/4-INCH, 6000 PSIG, ACCESSORY PRODUCTS COMPANY, PART NO. 5072X1004-(13, 23) TEST REPORT**
G. Collins 15 May 1968 107 p
(Contract NAS8-4016)
(NASA-CR-97875; TR-RE-CCSD-F0-1136-3) Avail: CFSTI CSCL 13K

Three specimen valves were tested to qualify a modified bonnet assembly which includes the plug and soft seat. Specimen 1 had a modified sealing surface on the plug using a Kel-F 81 soft seat and a V ring Teflon packing around the stem. Specimens 2 and 3 incorporated a new seat design using a Vespel SP-1 soft seat and Teflon V ring packings for stem seals. Specimen 1 leaked excessively during the initial functional test. A new hard seat was installed and proof pressure, functional, and surge tests were performed satisfactorily. A new bonnet assembly converting to the Vespel SP-1 seat was installed in specimen 1 and a seat erosion test was performed, but the stem threads galled. Specimen 2 leaked slightly during the functional test. Testing was continued until cycle 987, after the modified seat retainer was replaced by an original type, threaded areas were cleaned, and the plug end of the stem sheared loose. Specimen 3 leaked excessively during the functional test. An original type seat retainer replaced the modified version which again caused poppet galling, and the specimen performed satisfactorily until cycle 424 when the stem threads galled. Author

**N69-13143*#** SKF Industries, Inc., King of Prussia, Pa. Engineering and Research Center.
**EXTREME TEMPERATURE AEROSPACE BEARING LUBRICATION SYSTEMS Final Report**
L. A. Peacock and W. L. Rhoads 31 May 1968 100 p refs
(Contract NAS3-7912)
(NASA-CR-72446; SKF-AL68T005) Avail: CFSTI CSCL 13I

Angular-contact ball bearings (25mm bore) made with vacuum melted M50 steel rings and balls and M1 steel cages, and bearings made of WB49 steel rings and M1 steel balls and cages were endurance tested. Smearing failures predominated. These results indicate that Mobil XRM-177F provides marginal lubrication at 700°F, but, if adequately lubricated, WB49 steel bearings probably do not have any drastic reduction in spalling fatigue life at 700°F. The results also indicate that it is unlikely that long-term operation can be realized at 600°F with Krytox 143AC and M50 steel bearings. Lubricant film thickness measurements were made in the rolling contacts of ball bearings. Synthetic paraffinic hydrocarbon, improved ester, polyphenyl ether, perfluoro alkyl polyether were used. It was found that elastohydrodynamic lubricant films exist at extreme conditions but film thicknesses differ from those predicted, and that considerable differences exist in the thickness of films. Author

**N69-13256*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**STABILITY ANALYSIS FOR UNLOADED EXTERNALLY PRESSURIZED GAS-LUBRICATED BEARINGS WITH JOURNAL ROTATION**
David P. Fleming, Robert E. Cunningham, and William J. Anderson
Washington Dec. 1968 35 p refs
(NASA-TN-D-4934) Avail: CFSTI CSCL 13I

A small eccentricity analysis was performed for a bearing with two feeding planes, each of which is assumed to be a line source. Numerical results were obtained for a range of bearing number, pressure ratio, feeding parameter, and orifice recess volume. A digital computer program was written to obtain these results and is included. Steady-state load and attitude angle were obtained, as well as stability data. Stability decreased markedly with increasing recess volume; moreover, for large recess volume and low bearing number, an increase in pressure ratio decreased stability. There was no correlation between stability and steady-state attitude angle for any of the cases studied. Fair agreement was obtained with available experimental data. Author

**N69-13471*#** General Electric Co., Cincinnati, Ohio. Missile and Space Div.
**POWER TRAIN FOR THREE-STAGE POTASSIUM TEST TURBINE. VOLUME 1: FINAL DESIGN**
H. E. Nichols, R. W. Fink, and B. L. Moor 8 Nov. 1968 211 p
(Contract NAS3-10600)
(NASA-CR-72411; GESP-101) Avail: CFSTI CSCL 13I

The final design of the auxiliary drive and power absorbing system is presented for the three stage potassium vapor test turbine. The power train is designed for a 5000 hour life at a rotational speed of 18,250 rpm and a nominal power absorbing capacity of 328 horsepower. Although similar in overall geometry to the previously developed two stage potassium test turbine, the power train differed in detail as necessitated primarily by the requirement for 5000 hours continuous operation. The testing program identified for this test rig anticipates a pre-test mechanical checkout with speeds of from 0 to 21,000 rpm, followed by a potassium vapor performance test of approximately 100 hours, with varying rotational speeds of 15,000 to 20,000 rpm and a power absorption of up to 342 horsepower. This will be followed by a 5000 hour endurance test at the design point conditions defined. The design conditions, major assumptions, and pertinent analyses involved in the power train design, are included, along with descriptive graphs, figures, and drawings of actual test rig components and major assemblies of test equipment. Author

**N69-13571#** Army Materials and Mechanics Research Center, Watertown, Mass.
**A REPORT GUIDE TO RADIOGRAPHIC TESTING LITERATURE, VOLUME 3**
Satrak der Boghosian Sep. 1968 94 p refs
(AD-676835; AMMRC-MS-68-08-Vol-3) Avail: CFSTI CSCL 13/8

The report guide covers a portion of the abstracts on radiographic testing included in the holdings of the Nondestructive Testing Information Analysis Center. Author (TAB)

**N69-13808*#** Chrysler Corp., New Orleans, La. Space Div.
**SATURN 1B PROGRAM. TEST REPORT FOR GLOBE VALVE, 2 INCH, 6000 PSIG, VACCO VALVE COMPANY, PART NUMBER M-8P-X469-2G (WITH MODIFICATION KIT KM 7403)**
G. Collins 10 Aug. 1968 65 p
(Contract NAS8-4016)
(NASA-CR-97927; TR-RE-CCSD-1135-3) Avail: CFSTI CSCL 13K

This report describes the results of tests that were performed to determine if 2 Inch, Manually Operated Globe Valve 10428530 meets the operational and environmental requirements of John F. Kennedy Space Center Launch Complexes 34 and 37B. One specimen was tested. The valve has an operating pressure range from zero to 6000 psig. Globe Valve 10428530 is used in the high pressure helium system. Author

N69-13649# California Univ., Livermore. Lawrence Radiation Lab.
**BONDING STRAIN GAGES OR OTHER DEVICES TO BERYLLIUM METAL SURFACES**
Gerald R. Dittbenner 13 Aug. 1968 10 p Presented at the Advanced Strain Gage Seminar, Los Angeles, 19 Aug. 1968
(Contract W-7405-ENG-48)
(UCRL-71233) Avail: CFSTI

The most favorable and least hazardous surface preparation technique for bonding strain gages or other devices to beryllium metal is to etch the surface with a mild acid solution, rinse in running tap water, and clear with Neutralizer (a proprietary product). This process has been used successfully to bond all types of strain gages and adhesives to beryllium specimens. Author (NSA)

N69-13687# RAND Corp., Santa Monica, Calif.
**PRAM: A PRELIMINARY REPAIR LEVEL ANALYSIS MODEL**
Richard J. Kaplan, John Y. Lu, and Robert M. Paulson Sep. 1968 47 p
(Contract F44620-67-C-0015)
(AD-676271; RM-5752-PR) Avail: CFSTI CSCL 15/5

A description of a JOSS model, developed for the PACER TACK study, to analyze the cost tradeoffs between alternative repair level decisions. In deciding whether recoverable items should be repaired at the operating base or at a central depot, and whether AGE should be deployed to forward areas, the costs of AGE, AGE spares, facilities, personnel, and technical data must be balanced against the advantages of on-base repair, such as shorter turn-around time, flexibility, local control, self-sufficiency, reduced inventory cost, reduced shipping costs. PRAM, the Preliminary Repair Level Decision Analysis Model, uses the method of marginal analysis to determine the minimum-cost stock level to achieve a specified performance criterion. Given 26 simple inputs, PRAM outputs for each case (AGE available or not available at base) the (1) optimal stock levels by the METRIC standard and, if desired, by the AFM 67-1 method; (2) total stock cost; (3) yearly operating cost; (4) five-year operating cost; (5) five-year totals. Recomputation with one changed input requires less than one minute. Author (TAB)

N69-13693# RAND Corp., Santa Monica, Calif.
**ESTIMATION FROM ACCELERATED LIFE TESTS**
Richard E. Barlow and Ernest M. Schener Sep. 1968 43 p refs
(Contract F44620-67-C-0015)
(AD-676261; RM-5658-PR) Avail: CFSTI CSCL 14/4

Presented is a statistical technique for analyzing life test data from tests under overstress conditions. Usually the analyst simply assumes that the accelerated and normal use failure distributions belong to specified parametric families, such as the exponential distribution, and that the test experience is a scale transformation of reality. The new technique assumes only that (1) the failure rate is increasing on the average, and (2) test items in the overstress environment tend to fail sooner than those in normal use. Some data from the use environment are required, but may be scanty. Least squares estimators for the life distributions are developed, using both sets of data; quadratic programming may be used for computation. Procedures are given to test the validity of the assumptions used. Author (TAB)

# 16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N69-12786# Stanford Research Inst., Menlo Park, Calif.
**LIDAR OBSERVATIONS OF DEBRIS CLOUDS FROM NUCLEAR CRATERING DETONATIONS Final Report**
Ronald T. H. Collis and John W. Oblanas Aug. 1968 78 p refs Prepared for Calif. Univ., Livermore. Lawrence Radiation Lab.
(Contracts AT(04-3)-115; W-7405-eng-48)
(UCRL-13360) Avail: CFSTI

Lidar (laser radar) observations of the debris clouds resulting from nuclear cratering detonations are described. Observations were made of the Cabriolet and Buggy events at the Nevada Test Site, Nevada, on 26 January and 12 March 1968, respectively. The lidar data were analyzed to obtain data regarding cloud position, dimensions, and reflectivity for various times after detonation. The results are presented, the application of lidar to the monitoring of nuclear detonation clouds is discussed, possible future approaches are recommended. Author (NSA)

N69-12954# Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.
**FEASIBILITY OF THE LASER MICROPROBE FOR RAPID AND ECONOMIC URANIUM ISOTOPIC ANALYSIS Summary Report**
Philip L. Morris, Daniel F. Askey, and William M. Pardue 15 Sep. 1968 20 p refs
(Contract W-7405-eng-92)
(BMI-X-525) Avail: CFSTI

The feasibility of determining the isotopic content of uranium by a laser microprobe-emission spectrograph method was demonstrated. Uranium metal samples of varying isotopic composition from 0.04 to 93% $^{235}U$ were analyzed by the laser microprobe. Process parameters were defined and working curves correlating spectral line intensity ratio to $^{235}U$ concentration were established for samples with $^{235}U$ contents from 12 to 93%. Additional experiments performed to define the reproducibility of the data obtained with the relatively unsophisticated apparatus yielded values that were consistent within about ±5%. Author (NSA)

N69-13148# California Univ., Livermore. Lawrence Radiation Lab.
**LASER TELEMETRY PROGRAM**
W. E. Adams and R. R. Horning 3 Jul. 1968 35 p refs
(UCRL-50457) Avail: CFSTI

The Lawrence Radiation Laboratory at Livermore has supported the development of experimental laser telemetry systems to transmit nuclear diagnostic information. The basic concept of a laser telemetry system is described, problem areas are indicated, some experimental results obtained at the Nevada Test Site are given, and future plans are briefly mentioned. Author (NSA)

N69-13201*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**A GUIDE TO THE LITERATURE ON CARBON DIOXIDE LASERS (1 JANUARY 1964–30 JUNE 1968)**
John H. McElroy, Steven C. Flagiello, John B. McDay, and Harold E. Walker Nov. 1968 92 p refs
(NASA-TMX-63387; X-524-68-435) Avail: CFSTI CSCL 20E

The results are presented of a literature search on carbon dioxide lasers through scientific and technical journals. The results are presented in a chronological listing in which each item contains three sections. (1) a standard bibliographical listing, (2) an abstract of the paper or article, and (3) a comprehensive listing of keywords or phrases extracted from the publication. Author

**N69-13247*#** Maryland Univ., College Park. Dept. of Physics and Astronomy.

**LASER BEAM POINTING TESTS**

C. O. Alley and D. G. Currie Jun. 1968 11 p refs

(Grant NGR-21-002-019)

(NASA-CR-97924; TR-885) Avail: CFSTI CSCL 20E

An opportunity to verify the ability of earth stations for directing very narrow laser beams to a specific location on the lunar surface was provided by the detection sensitivity of the Surveyor VII vidicon camera operating in its integration mode. Such tests were of interest primarily because of a planned Apollo lunar surface experiment in which an astronaut will emplace a corner reflector array to provide a fixed point for very precise laser ranging. Estimates of the power density on the moon of a 10-W (transmitted) argon-ion laser beam contained within a divergence cone angle (half) of 10 sec of arc yielded a value 2.25 times the power density of a magnitude 0 star, or nearly magnitude −1. The power density would scale directly as the power transmitted and inversely as the square of the beam angle. Experience with star observations on previous Surveyor missions indicated that the laser beam could be easily observed if they were directed to illuminate the spacecraft. The diameter of the illuminated area on the moon is about 2 km per arc second of divergence. Author

**N69-13248*#** Maryland Univ., College Park. Dept. of Physics and Astronomy.

**PHOTON STATISTICS FOR THRESHOLD LASER LIGHT WITH FINITE COUNTING TIME**

R. F. Chang, R. W. Detenbeck (Vermont Univ.), and V. Korenman Jan. 1968 10 p refs

(Grants NGR-21-002-022; NsG-398; Contracts ARPA SC-101; DAHC04-67-C-0023)

(NASA-CR-97925; TR-788) Avail: CFSTI CSCL 20E

The 2nd, 3rd, and 4th cumulants of the distribution of light intensity from a He–Ne laser operating just below threshold have been measured as counting time is increased. The results agree with predictions computed under the assumption that the dependence of the correlation functions on the time variables is the same as for Gaussian light. Author

**N69-13489#** Army Electronics Labs., Fort Monmouth, N. J.

**ATMOSPHERIC EFFECTS ON DIGITALLY MODULATED LASER TRANSMISSION**

Merle M. Whatley and Donald A. Smith Jul. 1968 21 p refs

(AD-676814; ECOM-3005) Avail: CFSTI CSCL 17/2

This investigation has provided data which allow the evaluation of the laser as a transmission device for digital information. In particular, the effect of the atmosphere on laser propagation, modulation, and communication capabilities pertinent to tactical applications has been studied. These studies were made under varying conditions of weather, path length, optical power, modulation depth and modulation method. The characteristics of interest in each case was the bit-error rate obtained with binary serial bit streams. From this information, the operation of a laser PCM system may be forecast. Author (TAB)

**N69-13494#** Army Medical Research Lab., Fort Knox, Ky.

**SPOT SIZE AND BEAM PARAMETERS IN FUNDAMENTAL MODE LASER BEAMS**

George R. Peacock 10 May 1968 9 p refs

(AD-676809; USAMRL-774) Avail: CFSTI CSCL 20/5

Basic relationships between some laser beam parameters and three definitions of fundamental mode laser beam radius are described and tabulated. Two important laser parameters in laser dosimetry are percentage of beam powar contained within a radius r, and the ratio of peak to average power density over the same region. Author (TAB)

**N69-13502#** Kernforschungsanlage, Juelich (West Germany).

**MEASURING THE FAST FISSION FACTOR OF BERYLLIUM OXIDE BY MEANS OF THE MANGANESE SULFATE LASER TECHNIQUE AND A CADMIUM-LOADED LIQUID SCINTILLATOR [DIE MESSUNG DES SCHNELLSPALTPAKTORS VON BERYLLIUMOXID MIT HILFE DER MANGANSULFATBADTECHNIK UND EINES CADMIUMBELADNEN FLUESIGKEITSSZINTILLATORS]**

Norbert Kirch Aug. 1968 61 p refs

(JUL-547-RG) Avail: CFSTI

The fast fission factor resulted from a comparison of the counting rates of a Cf 252 fission neutron source in beryllium oxide samples and in non-multiplying samples of graphite and heavy water. Of the two measuring methods, the manganese sulfate bath technique was found to have a slightly energy-dependent threshold due to the 300 eV resonance and was therefore not quite reliable in proving neutron emission from the samples. The relatively low absorption cross section of the manganese sulfate solution caused a high thermal neutron flux, resulting in absorptions in the sample material; thus the largest samples required the greatest correction and had the greatest error. With the second measuring method, using the cadmium-loaded liquid scintillator, these corrections were not required because of the considerably higher toxicity of the liquid. This systems was found to be well suited for detecting neutrons with a constant degree of probability in a wide energy range. Although this method is more accurate, the results of both methods agree within error limitations. The fast fission factor of an infinitely extended beryllium oxide system was extrapolated from two beryllium oxide samples with radii of 7 cm and 9 cm. The same values resulted for both samples. Transl. by K.W.

**N69-13535*#** Maryland Univ., College Park. Dept. of Physics and Astronomy.

**OPTICAL RADAR BACKSCATTERING FROM THE MESOPAUSE REGION DURING JULY AND AUGUST 1967**

Eric C. Silverberg and Sherman K. Poultney Dec. 1967 35 p refs

(Grant NGR-21-002-022; Contracts ARPA SD-101; DAHC04-67-C-0023)

(NASA-CR-97016; TR-765) Avail: CFSTI CSCL 20E

Optical radar studies of the atmosphere above 40 km were continued at the University of Maryland in July and August, 1967. Changes in the system components resulted in some gain in efficiency over that obtained earlier. The observed atmospheric returns from heights greater than 60 km show considerable structure and imply scattering cross sections not explained by the molecular atmosphere. Agreement with some previously published data is excellent. Author

**N69-13624*#** Maryland Univ., College Park. Dept. of Physics and Astronomy.

**COMMENTS ON A PROGRAMMED MULTIPULSE RANGE MEASUREMENT SYSTEM**

S. K. Poultney Jul. 1967 7 p refs

(Grant NGR-21-002-109; Contract DAHC04-67-C-0023; Proj. Defender)

(NASA-CR-97906; TR-695) Avail: CFSTI CSCL 20E

The efficiency of a Q-switched laser radar was increased by extracting a number of Q-switched pulses at selected times during a single pump period controlled by a digital-clock-controlled programmer. The problems arising in practice due to the nature of the laser transmitter are pointed out. They are caused by the short term temperature changes in the laser rod during the pump cycle. Temperature changes will affect the wavelength of the output pulse and may cause one or more pulses of the multipulse to be absorbed in the atmosphere; they also affect the width, shape, energy, and delay from initiation of each of the Q-switched pulses. Reported measurements of the temperature rise are analysed and

it is concluded that the above laser radar system is practical if sufficient care is given to the laser design and range timing start pulse. B.P.

**N69-13842*#** Maryland Univ., College Park. Dept. of Physics and Astronomy.
**CORRELATIONS IN LIGHT FROM A LASER AT THRESHOLD**
R. F. Chang, V. Korenman, C. O. Alley, and R. W. Detenbeck Sep. 1968 47 p refs
(Grants NGR-31-002-022; NGR-46-001-008; NsG-398; AF-AFOSR-735-65; Contracts ARPA SD-101; DAHC04-67-C-0023; N00014-67-A-0239-003; Proj. Defender)
(NASA-CR-97913; TR-883) Avail: CFSTI CSCL 20E

In this study, we measured the temporal correlations in the electromagnetic field radiated by a laser in the threshold region of oscillation, from 1/10 of threshold intensity to ten times threshold intensity. The experimental results are compared with theoretical predictions based on solutions of a Fokker–Planck equation. From photoelectron count distribution measurement, we calculated second, third, and fourth normalized cumulants of the intensity probability density function of the light field. The statistics of the photoelectron count distribution shows that the intensity fluctuations at about 1/10 threshold are nearly those of a Gaussian field and continuously approach those of a constant amplitude field as the intensity is raised to about 10 times threshold. The normalized 2nd, 3rd, and 4th cumulants of the intensity probability density function of the laser light were also measured at 17% and 42% of threshold intensity as counting time was increased from 3 microseconds to 1000 microseconds. The results agree with predictions computed. Author

**N69-13646#** General Telephone and Electronics Labs., Inc., Bayside, N. Y.
**HIGH-ENERGY PULSED LIQUID LASER**
A. Lempicki 10 Oct. 1968 3 p
(Contract N00014-68-C-0110; Proj. Defender)
(AD-676899; TR-68-826.5) Avail: CFSTI CSCL 20/5

The objectives of the research are to develop a closed circulating laser material system looking at the problems associated with flow along the axis of the laser and across the axis of the laser, and to develop cavity designs compatible with the circulating laser liquid so as to be compatible with laminar flow and to optimize the efficiency of the laser output and the beam spread of the output. Author (TAB)

**N69-13680*** Maryland Univ., College Park. Dept. of Physics and Astronomy.
**LASER RANGING TO LUNAR RETROREFLECTORS: A. SIGNAL DETECTION, LOCATION IN RANGE-TIME, AND TIMING PRECISION. B. LASER PULSE UNIFORMITY AND TIMING**
S. K. Poultney Aug. 1967 13 p refs
(Grant NGR-21-002-022)
(NASA-CR-97915; TR-725) Avail: CFSTI CSCL 20E

Several recommendations are proposed to implement studies on laser ranging to optical retroreflectors on the moon. Detection statistics are being recalculated on the basis of considering that the signal return for the array of retroreflectors will not be constant, but will be Bose distributed about the expected return. The advantages of the higher returns are discussed. Problems in signal location in range and time are reviewed. Precise timing of the signal is explored; the immediate problem encountered with using a discriminator is its deadtime. The limitations of achieving laser pulse uniformity are mentioned. B.P.

**N69-13835#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INITIATION OF DETONATIONS IN CONDENSED EXPLOSIVES WITH A LASER [VOZBUZHDENIE DETONATSII KONDENSIROVANNYKH VV IZLUCHENIEM OPTICHESKOGO KVANTOVOGO GENERATORA]**
A. A. Brish et al 16 Nov. 1967 5 p refs Transl. into ENGLISH from Fiz. Goreniya Vzryva (Novosibirsk), no. 3, 1966 p 132–133
(AD-676263; FTD-HT-23-990-67) Avail: CFSTI CSCL 19/1

Previous experiments have shown that strong light pulses from gas discharge lamps can initiate detonations of primary but not of secondary explosives. The present study showed that detonations of lead azide and PETN can be induced by a Q-modulated laser. The laser contained a neodymium glass plate (10 x 120 mm) and was Q-modulated with a rotating prism (25,000 rpm). The starting pulse was recorded on one track of an OK-21 oscillograph. The signal from another photocell recorded on the second track indicated the instant when the detonation wave reached the end of the charge. The explosives with a 1 g/cc density were placed in an organic glass shell with a 10 mm inner diameter and a height of 5 mm. The starting pulse had an energy of 10 Mw, a duration of 0.1 msec, and a beam diameter of 15 mm. The lead azide was detonated with a laser beam energy on the surface of 0.08 Mw/sq mm, while the PETN detonated only at considerably higher intensities attained by focusing the beam. This intensity was higher than that achieved by ordinary light pulses. The results also showed that transition to detonation is as fast as in impact-detonated charges. This was proved by using the charge detonated by the laser to detonate a second charge placed behind it. TAB

# 17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

**N69-12794** Illinois Univ., Urbana.
**THE ANODIC OXIDATION OF METALS**
Donald John De Smet (Ph.D. Thesis) 1967 125 p
Avail: Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 68-1740

Optical measurements of anodic oxide surface layers on passive iron electrodes have been made and are compared with electrical measurements of the capacitance and other overpotential parameters. Results of these studies show that the surface layer on the electrode may be regarded as consisting of more than one part. Specifically in a neutral electrolyte there is a thin conducting layer of constant thickness present on the electrode surface in addition to the electrically limiting layer of variable thickness, while in acid electrolyte there is a layer located outside the electrically limiting layer which grows at a constant rate to large thickness when the electrode is held in the steady state in the passive region. This thick layer can be removed by holding the electrode at a potential slightly below the passive region. Changes in the thickness of the electrically limiting layer, determined optically are consistent with a field dependent conduction mechanism. Dissert. Abstr.

**N69-12865** Illinois Univ., Urbana.
**INFLUENCE OF THERMAL AND STRAIN CYCLING ON FRACTURE SUSCEPTIBILITY OF MILD STEEL**
John Frederick Kiefner (Ph.D. Thesis) 1967 129 p
Avail: Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 68-1787

The objective of this investigation was to evaluate the influence of thermal and strain cycling on the fracture behavior of mild steel

and the relationship of such cycling to the fracture susceptibility of certain regions of the parent material in welded plates. The principal fracture controlling parameters and the effects of welding thereon are discussed. From the results of tests on notched and welded specimens it is apparent that the effect on fracture behavior of the thermal and strain cycling that occurs during welding is not fully understood. Notched bend specimens subjected to a cycle of axial prestraining at temperatures usually in the range of 300° to 800°F were tested to evaluate the fracture behavior of three structural steels, ABS-C, A212-B, and A441 steels. Dissert. Abstr.

**N69-12894** California Univ., Berkeley.
**VACANCY MODELS FOR CONCENTRATED BINARY ALLOYS**
Ching-Yao Cheng (Ph.D. Thesis) 1967 84 p
Avail: Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 68-44

Four models for estimating the effect of ordering or clustering on the equilibrium concentration of vacancies in binary alloys are developed in terms of statistical thermodynamics. The models differ with respect to the details with which vacancy environments are inspected and with reference to methods of estimating vacancy energies. The effect of short-range ordering or clustering on the equilibrium vacancy concentrations is calculated. All models suggest that the vacancy concentration decreases as a result of ordering. The effect of long-range ordering on the equilibrium number of vacancies in binary alloys with $L2_0$ (b.c.c.) or $L1_2$ (f.c.c.) superlattice is discussed. All four models suggest that, in general, the concentration of vacancies differs on the different types of lattice sites when the alloy is ordered. Dissert. Abstr.

**N69-12902** Wisconsin Univ., Madison.
**STRUCTURAL STUDIES OF SOME TRANSITION METAL COMPLEXES**
Jo Ann Molin Case (Ph.D. Thesis) 1967 94 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 67-10624

Three-dimensional x-ray crystallographic data have been recorded at room temperature for three transition metal compounds, $Fe_2(CO)_5(C_2H_5C_2C_2H_5)_3(CO)$, $Co_2(CO)_6[P(OC_6H_5)_3]_2$, and $W(CO)(C_2H_5C_2C_2H_5)_3$. The structures of the iron and cobalt complexes were determined and refined, but for the tungsten compound only the tungsten atom could be located unambiguously on electron density maps. Therefore, a low temperature attachment for the Weissenberg x-ray camera was constructed with the expectation that data collected at a lower temperature would reveal the positions of the lighter atoms. Dissert. Abstr.

**N69-12914#** Instituto Sperimentale dei Metalli Leggeri, Milan (Italy).
**FURTHER DEVELOPMENTS OF THE INVESTIGATIONS ON Al-Zn-Mg WELDABLE ALLOYS Final Technical Report, Feb. 1967–Mar. 1968**
Ettore Di Russo Apr. 1968 77 p refs
(Contract DAJA37-67-C-0387)
(AD-676107) Avail: CFSTI CSCL 11/6

Investigations on four ternary Al-Zn-Mg alloys with Cr, Mn and Zr additions have been carried out. Two alloys (Al-4%Zn-2%Mg and Al-4%Zn-3%Mg) were rolled and two alloys (Al-5%Zn-1%Mg and Al-4%Zn-2.7Mg) were extruded. Experimental parameters which were varied were quench rate and ageing treatment. Investigations performed were: tensile and stress-corrosion tests; hardness measurements; fatigue tests on unnotched and notched specimens at room temperature and -196C; examinations of microstructure by electron microscopy. Complete experimental results are given and conclusions based on these are reached. These indicate the relationship of stress-corrosion resistance to quench rate and heat treatment cycle, the relationship of ductility to quench rate, and relationship of composition to fatigue strength. An explanation for the observed changes in stress-corrosion resistance and ductility is offered in terms of the precipitate distribution in the microstructure. Author (TAB)

**N69-12935** Cornell Univ., Ithaca, N. Y.
**EFFECT OF GRAIN SIZE AND TEMPERATURE ON THE STRENGTHENING OF NICKEL AND NICKEL-COBALT ALLOYS BY CARBON DURING PLASTIC FLOW**
Daniel Eugene Sonon (Ph.D. Thesis) 1967 126 p
Avail: Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 68-677

Three levels of carbon were used in Ni, Ni–20% Co, and Ni–60% Co alloys to determine the mechanism by which carbon strengthens FCC Ni and Ni–Co alloys, and to assess the effect of a change in stacking fault energy on strengthening by carbon. The carbon content of Ni and Ni–Co alloys was varied by annealing in dry hydrogen, and the grain size was varied by recrystallizing at various temperatures and water quenching. Tension tests were made on 70 mil wire at 78, 195, and 300°K and at four grain sizes to determine the variation of yield stress, yielding behavior, and the Hall–Petch slope with carbon concentration. Also, serrated plastic flow was investigated from 300 to 800°K and thermal activation was studied at 78, 195, and 300°K by differential strain rate tests. Dissert. Abstr.

**N69-12978** Brown Univ., Providence, R. I.
**ULTRASONIC ATTENUATION STUDIES IN POTASSIUM AND BERYLLIUM**
Allan Richard Hoffman (Ph.D. Thesis) 1967 122 p
Avail: Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 68-1466

Overhauser's suggestion that potassium is not a free electron metal, but is a metal whose ground state is a finite amplitude spin density wave state, has not met with universal acceptance. The determination of absorption edges in the ultrasonic attenuation associated with Doppler shifted cyclotron resonance of longitudinal sound waves, propagated at oblique angles to a dc magnetic field, is capable, in principle, of distinguishing between the two models. Studies of such edges in potassium, as well as studies of the general features of the attenuation for oblique propagation, have been carried out. Ultrasonic studies in beryllium at liquid helium temperatures have been conducted in magnetic fields up to 80 kilogauss, and for frequencies ranging to 780 Mc/sec. At fields below a few kilogauss, the attenuation is believed to exhibit geometric resonance oscillations associated with both hole and electron orbits. Dissert. Abstr.

**N69-12994#** Kernforschungsanlage, Juelich (West Germany).
**INTERNATIONAL CONFERENCE ON VACANCIES AND INTERSTITIALS IN METALS, VOLUME 2**
Sep. 1968 452 p refs Conf. held at Juelich, West Ger., 23–28 Sep. 1968; sponsored by Intern. Union of Pure and Appl. Phys. and the Bundesministerium fuer Wiss. Forsch.
(JUL-Conf-2-Vol-2) Avail: CFSTI

Papers are presented on point defect phenomena in metals and on experimental procedures for obtaining more detailed information on the defects. The particular areas investigated are theoretical and experimental studies, vacancies and interstitials in b.c.c. and h.c.p. metals, and interstitial impurities. For individual titles, see N69-12995 through N69-13028.

**N69-12995#** Ludwig-Maximilians-Universitat, Munich (West Germany). Sektion Physik.

**ANNEALING BEHAVIOUR OF MONOCRYSTALLINE GOLD FILMS IRRADIATED WITH <100>-CHANNELED 30-60 keV GOLD IONS AT MINUS 196°C**

K. Wittmaack *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 473-481 refs (See N69-12994 03-17)

Avail: CFSTI

A single crystal gold film of (001) orientation, 3000 Å thick, was irradiated with a beam (divergence smaller than 0.1°) of 30 and 60 keV gold ions in <101> at −196°C. Successive isochronal annealing showed a pronounced recovery peak centered at −15°C. The activation energy for this annealing process was evaluated by means of cyclic step annealing yielding $E^M$ = (0.78 ± 0.06) eV. Author

**N69-12996#** California Univ., Berkeley. Lawrence Radiation Lab.

**A FIELD ION MICROSCOPE INVESTIGATION OF 10 MeV PROTON DAMAGE IN IRIDIUM**

P. Petroff and J. Washburn *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 485-498 refs Supported by AEC (See N69-12994 03-17)

Avail: CFSTI

Annealed iridium specimens of 99.99% purity were irradiated at 5°K with 10 MeV protons in a field ion microscope attached to a cyclotron. Contrast effects due to point defects and their clusters were analyzed. By a field evaporation technique the point defect distribution in the bulk was investigated. Interstitial migration to the surface was directly observed upon annealing in the temperature range 15°K to 42°K. The decrease in the bulk concentration of interstitials during annealing in the temperature range 5°K to 300°K indicated that stage I is caused by interstitial migration to close-by vacancies and traps and stage II was due to interstitial detrapping. Damage caused by irradiation at 5°K was compared to that introduced at 300°K. The damage formed of large voids (400 to 500 vacancies) and dislocation loops suggested a different formation mechanism in the specimens irradiated at higher temperature. Author

**N69-12997#** Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Angewandte Kernphysik.

**RADIATION EFFECTS IN ORDERED Fe-Al ALLOYS: MOESSBAUER EXPERIMENTS FOLLOWING NEUTRON CAPTURE**

Wolfram G. Berger and Gordon Czjzek *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 504-513 refs Supported in part by AEC (See N69-12994 03-17)

Avail: CFSTI

Mössbauer effect with $Fe^{57}$ following neutron capture in $Fe^{56}$ was investigated in Fe-Al alloys in the concentration range from about 26 to 52 at. % Al. In ordered alloys of CsCl structure we observed line shifts due to recoil effects following neutron capture. In a $Fe_3Al$ alloy of $DO_3$ type order additional changes in the internal magnetic fields were found. Both effects are discussed in terms of possible final positions for the primary recoiled iron atom in the lattice. Author

**N69-12998#** Lausanne Univ. (Switzerland).

**INTERACTION BETWEEN POINT DEFECTS AND DISLOCATIONS IN GOLD**

P. A. Grandchamp, W. Benoit, B. Bays, and B. Vittoz *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 517-530 refs (See N69-12994 03-17)

Avail: CFSTI

In high purity gold (99.999%), poly-and monocrystalline, point defects and dislocations were created by cold-working and neutron irradiations. The internal friction and Young modulus were measured as a function of temperature on three installations: a torsion pendulum, an imbedded foil vibration installation, and a bar vibration installation. In the temperature range of −180°C to +200°C, we have observed relaxation peaks produced by interactions between point defects and dislocations. These peaks are accompanied by pinnings and depinnings having an appreciable influence on modulus defect. The study of the migration properties of these defects enables their identification. Finally, a model is proposed, which gives possible mechanisms of the phenomena observed. Author

**N69-12999#** Wake Forest Coll., Winston-Salem, N. C.

**DISLOCATION-INTERSTITIAL INTERACTIONS IN SINGLE CRYSTAL TANTALUM**

Richard C. Sanders and Thomas J. Turner *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 531-545 refs Supported in part by AEC (See N69-12994 03-17)

Avail: CFSTI

The amplitude dependent (hysteretic) decrement of high purity single-crystal tantalum was measured with a composite oscillator operating at approximately 50 KHz in the temperature range 200° to 400°K. Linear Granato-Lücke plots were obtained whose slopes give a binding energy for oxygen to the dislocation of 0.025 eV. This appears unrealistic since it is smaller than kT for some temperatures employed. Assuming an Arrhenius temperature dependence for the hysteretic decrement a stress dependent binding energy was obtained. The data extrapolate to a zero stress binding energy of 0.26 eV and a maximum breakaway stress of $2.7 \times 10^6$ kg/m$^2$. A high temperature modification to the Granato-Lücke theory utilizing a force approach was found to be inadequate for this system. Author

**N69-13006#** Commissariat a l'Energie Atomique, Saclay (France). Dept. de Metallurgie.

**CALCULATION OF VACANCY MIGRATION ENERGIES IN ALUMINUM AND LITHIUM**

I. M. Torrens and M. Gerl In Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 619-633 refs (See N69-12994 03-17)

Avail: CFSTI

Migration energies of vacancies in aluminum and lithium were calculated using an interatomic potential determined by an OPW pseudopotential method. This differs from potentials of the Born-Mayer and Morse types in that it is an oscillating potential, taking into account directly the ion-electron-ion interactions and stability of the crystal. The method of calculation is that of computer simulation of a section of lattice containing the vacancy in different stages of its migration, convergence and kinetic disturbance propagation criteria determining the volume of lattice permitted to relax around the defect. The effect of the oscillating potential is described and the results are reviewed in the light of its relative accuracy in the two metals chosen. Author

**N69-13006#** Lausanne Univ. (Switzerland).

**THE ACTIVATED STATE ASSOCIATED TO THE VACANCY JUMP**

J.-J. Paltenghi *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 634-642 refs Supported by Swiss Fund for Sci. Res. (See N69-12994 03-17)

Avail: CFSTI

Only traces of the vacancy jump are observed. The crystalline states anterior and posterior to the jump differ generally by a displacement of the lattice. Then a description of the phenomenon implies an intermediate construction being either a transition

hypersurface according to the Vineyard's treatment, or an activated state. Both possibilities are studied by the light of the vacancy concept. The vacancy jump is joined to the melting phenomenon in the same way as a local destruction is connected to the global destruction of the lattice. So recognized, this information determines for the crystalline state a statistical distribution which is not a canonical one. This point of view leads to satisfactory results. Author

**N69-13009#** Technische Hogeschool, Delft (Netherlands). Lab. voor Metaalkunde.

**A THEORY OF THE KINETICS OF SHORT-RANGE ORDER IN BINARY ALLOYS**

S. Radelaar *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 667–677 refs (See N69-12994 03-17)

Avail: CFSTI

An equation is derived which relates the relaxation time for the establishment of short-range order with the selfdiffusion coefficents of the components of the alloy. If the diffusion coefficients of the components are very different the relaxation time for short-range ordering is determined by diffusion of the slowest component. Under certain conditions however, the activation energy for short-range ordering is lower than the activation energy of the fastest component. Author

**N69-13010#** Battelle Memorial Inst., Richland, Wash. Pacific Northwest Lab.

**SOME OBSERVATIONS ON THE ANNEALING OF NEUTRON-IRRADIATED SINGLE-CRYSTAL AND POLY-CRYSTALLINE MOLYBDENUM**

H. E. Kissinger, J. M. Brimhall, B. Mastel, and T. K. Bierlein *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 681–692 refs (See N69-12994 03-17)

(Contract AT(45-1)-1830)

Avail: CFSTI

The work described in this paper was undertaken to re-examine the stage III annealing behavior of molybdenum by simultaneous lattice parameter and length change measurements, together with stored energy release measurements, during annealing of high purity samples. Single-crystals produced by multiple zone-refining of selected high-purity stock was the source of the very pure sample material used in the studies and allowed very precise measurements of lattice parameter. Author

**N69-13011#** Battelle Memorial Inst., Richland, Wash. Pacific Northwest Lab.

**PRESSURE INDUCED RECOVERY OF IRRADIATION DAMAGE IN MOLYBDENUM**

G. L. Kulcinski, H. E. Kissinger, and B. Mastel *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 693–708 refs (See N69-12994 03-17)

(Contract AT(45-1)-1830)

Avail: CFSTI

Polycrystalline molybdenum irradiated to $6.2 \times 10^{18}$ n/cm$^2$ was post-irradiation annealed at two pressures: < 1d 20,000 bars. Electrical resistance, lattice parameter, hardness, and electron microscopy tests reveal that there are four recovery stages above room temperature at low pressure. 0.15 $T_m$ (stage III), 0.24 $T_m$ (stage IV-B), and 0.35 $T_m$ (stage V). The activation energy for stage III is 1.25 ± 0.09 eV and the annealing kinetics are complex, but suggestive of second order. The electrical resistance is completely recovered by stage IV-B, whereas, the lattice parameter, hardness and cluster density measurements are not fully recovered until stage V. Annealing under 20 kbars pressure caused the stage III and stage V peaks to be lowered by 60°C and 300°C, respectively. An additional recovery peak at 350–375°C was found when annealing under pressure. The direction of the stage III shift with pressure indicates that the migrating defect has a negative activation volume for migration. The pressure induced recovery of defect clusters indicates that either the mobility or stability of these clusters is greatly affected by stress. Author

**N69-13012#** Surrey Univ., London (England). Dept. of Metallurgy and Materials Technology.

**EFFECT OF OXYGEN ON "STAGE III" RECOVERY IN COLD WORKED NIOBIUM**

Z. C. Szkopiak and B. Pouzet *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 709–723 refs (See N69-12994 03-17)

Avail: CFSTI

Electrical resistivity of electron-beam-melted niobium containing varying amounts of oxygen was measured at 273° and 77°K. At both temperatures the resistivity shows a linear relationship with oxygen content. The increase of resistivity due to cold working was found to be oxygen calculated from the area under the stress-strain curve. Calculations based on energy of dislocations have shown that only 10% of the change in resistivity is due to dislocations introduced by cold work. On annealing cold-worked specimens the resistivity recovers with an activation energy of 1.10 eV. This value is of the order of magnitude of activation energy for the diffusion of oxygen in niobium. From the comparison of resistivity recovery curves with those of yield point return and internal friction, it was deduced that the recovery of resistivity in annealing is mainly due to Cottrell atmosphere formation at dislocations. Author

**N69-13013#** Max-Planck-Institut fur Metallforschung, Stuttgart (West Germany). Inst. fuer Physik.

**RECOVERY STEPS IN ELECTRON IRRADIATED TANTALUM**

H. Hammarich (Kernforschungsanlage), D. Meissner (Kernforschungsanlage), H. Schultz, and F. Walz *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 724–732 refs (See N69-12994 03-17)

Avail: CFSTI

Some isochronal annealing studies of high purity and oxygen doped tantalum were performed after irradiation with 3 MeV electrons at 4.5°K. Resistivity recovery steps are correlated to similar steps in tungsten; however, these recovery steps occur in tantalum at much lower temperatures. Following recent results on tungsten, as a working hypothesis a two interstitial model is applied, with a freely migrating interstitial in stage I and a second interstitial-type defect migrating in stage III. In the lines of this model vacancy migration should occur in a stage IV at 250°K, which is exceptionally low for this high melting point material. Author

**N69-13014#** Technische Univ., Berlin (West Germany). Inst. fuer Metallphysic.

**QUENCHING EXPERIMENTS WITH HIGH PURITY IRON**

W. Glaeser and H. Wever *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 733–750 refs (See N69-12994 03-17)

Avail: CFSTI

Iron wire of extreme purity was quenched in a helium cryostat. Changes in electrical resistivity were used to measure the recovery during isochronal and isothermal anneals in the temperature range 4.2°–1000°K. Two sharp recovery stages were observed (first stage 300°K < T < 400°K, second stage 400°K < T < 520°K). The activation energy was determined by the change in slope and Meechan-Brinkman test (first stage 0.48 ... 0.61 eV, second stage 1.05 ... 1.1 eV). Both recovery processes follow a first order kinetic law. These two stages are observed after cold work

as well. The first stage is attributed to the migration of carbon atoms alone and paired with vacancies, the second stage corresponds to the migration of vacancies. The recovery spectrum exhibits in three different temperature ranges a not very reproducible resistivity increase as well as a final recovery stage in the range of 850°–1000°K. The last increase and recovery stage may be due either to the redissolution of carbon atoms or to Bloch wall motion.
Author

**N69-13015#** Commissariat a l'Energie Atomique, Grenoble (France).
**POINT DEFECTS IN IRON**
H. Bilger, V. Hivert, J. Verdone, J. L. Leveque, and J. C. Soulie *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 751–767 refs (See N69-12994 03-17)
Avail: CFSTI

The principal methods used for studying the annealing behavior in iron are measurements of resistivity, magnetic after-effect, stored energy, and internal friction. Presented are recent results obtained from detailed studies based on the methods indicated above. Included are investigations of the elastic properties of polycrystalline iron and internal friction in monocrystalline iron. The discussion contains a comparison of the results yielded by these different methods in an attempt to help identify the various point defects responsible for the observed phenomena.
Author

**N69-13016#** Oak Ridge National Lab., Tenn. Solid State Div.
**A SUMMARY OF THERMAL NEUTRON DAMAGE EFFECTS IN CADMIUM**
R. R. Coltman, Jr., C. E. Klabunde, J. K. Redman, and A. L. Southern *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 771–781 refs Supported by AEC (See N69-12994 03-17)
Avail: CFSTI

The isochronal annealing of the damage produced by thermal neutron irradiation of cadmium at 3.6°K shows a strong dependence upon initial dose. This effect, which is not seen to this extent in the fcc metals, cannot be accounted for by an irradiation annealing mechanism. Irradiation annealing effects observed during the production of damage at high defect concentrations indicate that the spontaneous annihilation volume between the defects of a new capture event and the defects from an earlier event is 80 atomic volumes. Other results suggest that damage production and recovery mechanisms are closely associated with the anisotropic nature of the cadmium hexagonal lattice.
Author

**N69-13017#** Commissariat a l'Energie Atomique, Saclay (France). Dept. de Metallurgie.
**MIGRATION AND PRECIPITATION OF VACANCIES IN QUENCHED MAGNESIUM**
V. Levy, J. Hillairet, D. Schumacher, G. Revel, and T. Chaudron *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 783–791 refs (See N69-12994 03-17)
Avail: CFSTI

An attempt is made to freeze-in individual vacancy type defects by quenching to temperatures below room temperature. The precipitation of frozen-in defects were studied by parallel experiments using electrical resistivity and transmission electron microscope techniques. A further progress over earlier studies is due to the fact that high purity zone refined magnesium was available.
Author

**N69-13018#** Commissariat a l'Energie Atomique, Grenoble (France).
**POST-IRRADIATION RECOVERY OF TWO HEXAGONAL FERROMAGNETIC METALS: COBALT AND GADOLINIUM**
H. Cope, G. Sulpice, C. Minier, H. Bilger, and P. Moser *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 792–801 refs (See N69-12994 03-17)
Avail: CFSTI

Previous experiments with iron and nickel have shown striking similarities between the defects in these two metals. It is of interest to determine whether these similarities are maintained in metals with a hexagonal structure, and whether the difference from the ideal structure plays a role for metals in this same group. Some properties are summarized of the two metals used in the discussion. Cobalt and gadolinium have a close packed hexagonal structure. The ratio c/a is 1.623 for cobalt and 1.59 for gadolinium compared with the ideal value of 1.633. In cobalt the spontaneous magnetisation direction is along the C axis. In gadolinium the magnetisation direction is tilted from the C axis by an angle $\Theta$ which is temperature dependent being of the order of 30° at T = 100°K.
Author

**N69-13019#** Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
**ON THE RECOVERY OF PLASTICALLY DEFORMED RHENIUM**
H. Vandenborre, L. Stals, and J. Nihoul *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 802–807 refs (See N69-12994 03-17)
Avail: CFSTI

Resistometric recovery data are described for pure rhenium foils following plastic deformation at room temperature to various degrees (4 to 20% reduction in thickness). Four recovery stages labelled A, B, C, and D can be distinguished between 300° and 820°K. Stage C, at about 0.18 $T_m$ is associated with an activation energy of 2.2 ± 0.1 eV. This stage is most pronounced and shows some similarities with stage III of other hexagonal and cubic metals. It is tentatively ascribed to the migration of interstitials to vacancies.
Author

**N69-13020#** Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France).
**FISSION DAMAGE IN ALPHA-URANIUM AT 4°K**
J. Leteurte *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 808–821 refs (See N69-12994 03-17)
Avail: CFSTI

Samples irradiated at several burn-up were examined. In order to explain our micrographic results, and also all informations gathered in literature about radiation damage in $\alpha$-uranium, a coherent model is proposed for the fission particles effects. The number of point defects created by one initial fission is determined for pure and annealed metal. The importance of the self-anneal which occurs immediately in each displacement spike, and the anneal due to a new fission on the damage resulting from a previous fission, are estimated. The focussing distance in [100] direction is found to be about 1000 A. at 4°K.
Author

**N69-13021#** Brookhaven National Lab., Upton, N. Y.
**THE INFLUENCE OF INTERSTITIAL CARBON IN IRON ON THE SCATTERING OF X-RAYS**
A. N. Goland and D. T. Keating *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 825–839 refs Supported by AEC (See N69-12994 03-17)
Avail: CFSTI

Using recent calculations of the doublet-force displacement field about a carbon interstitial in $\alpha$-iron, we have calculated the X-ray diffuse scattering in the vicinity of the reciprocal lattice

points in iron-carbon martensite and in ferrite. Contours of the diffuse scattering in electron units per iron atom divided by p(1-p), where p is the fraction of carbon atoms, are given for both martensite and ferrite. In martensite the contours are of a complicated shape, often quite different from those for defects with spherical symmetry. Reflections of the type (OOL) and (HKO) always show nodal planes perpendicular to the vector from (OOO) to (HKL). The diffuse scattering at (OOO), the small angle scattering shows the cylindrical doublet symmetry. In ferrite, the contours are even more complicated, some displaying no nodal surfaces. Reflections of the type (HOO), (OKO), or (OOL) show nodal planes perpendicular to the vector from (OOO) to (HKL). The results for martensite and ferrite reveal that the origin scattering exhibits the orientation and symmetry of a defect in a more direct manner than the diffuse scattering about any other point in reciprocal space. Author

**N69-13022#** Missouri Univ., Columbia. Dept. of Metallurgical Engineering.

**ISOTOPE EFFECT OF CARBON DIFFUSION IN A Fe-Si ALLOY**

M. Wuttig and E. T. Yen *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 840-851 refs Supported in part by Am. Iron and Steel Inst. (See N69-12994 03-17)
(Grant NSF GK-2678)
Avail: CFSTI

The isotope effect of carbon diffusion in dilute iron silicon alloys containing $^{28}Si$ and $^{30}Si$ was measured below room temperature using the disaccommodation technique. The time dependence of the reluctivity was analyzed in terms of two relaxation processes which are due to the reorientation of carbon interstitials in Fe-Fe and Fe-Si sites respectively. The ratio of the relaxation times of the two carbon isotopes $^{13}C$ and $^{12}C$ $\tau_{13}/\tau_{12}$ is 1.038 for the former and 1.01 for the latter process in the Fe+$^{28}$Si alloy. The ratios of the relaxation times of the same carbon isotope $^{12}C$ contained in a dilute Fe+$^{30}$Si and in a dilute Fe+$^{28}$Si alloy respectively $\tau_{30}/\tau_{28}$ are 0.995 and 1.022 for the two processes mentioned. These results demonstrate clearly the many body aspects of the diffusional process. Author

**N69-13023#** Nagoya Univ. (Japan).

**EFFECT OF CHROMIUM ON THE BEHAVIOUR OF NITROGEN IN ALPHA IRON**

H. Hotta (Nagoya Munic. Ind. Res. Inst., Japan) and Y. Iwama *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 852-857 refs (See N69-12994 03-17)
Avail: CFSTI

The effect of chromium on the behaviour of nitrogen in $\alpha$-iron was investigated by means of the damping method. For dilute concentration of chromium, the damping curves can be resolved primarily into the sum of two peaks, assuming that each relaxation time exhibits a lognormal distribution. From the variation of each peak height with chromium content, it may be deduced that there are about 380 interaction sites around each chromium atom and their interstitial potential is lower by about 0.1 eV than the normal one. Such an extensive influence of chromium suggests that it may be originated from the chemical or electronic interaction between chromium and nitrogen. Author

**N69-13024#** United Kingdom Atomic Energy Authority, Harwell (England). Metallurgy Div.

**THE HEAT OF SOLUTION AND DIFFUSIVITY OF NITROGEN IN MOLYBDENUM**

J. H. Evans and B. L. Eyre *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, vol. 2 Sep. 1968 p 858-869 refs (See N69-12994 03-17)
Avail: CFSTI

A study was made of the solubility and diffusivity of nitrogen in high purity molybdenum making use of liquid helium resistivity measurements to monitor the presence of nitrogen. The heat of solution was found by measuring the variation of quenched-in resistivity with quenching temperature after equilibration in a nitrogen atmosphere. The measured heat of solution was 0.80 ± 0.01 eV. The diffusivity was measured by following the rate of evolution of nitrogen from the molybdenum specimens. By carrying out this experiment at different temperatures it was found that the diffusivity obeyed the equation $D = 3.0 \cdot 10^{-3} \exp(-1.2\ eV/kT)\ cm^2/sec$. The results are compared with previous workers. By combining the results with those of Smithells and Ransley's value of $1.2 \cdot 10^{-6}$ $\Omega$cm was calculated for the resistivity per atomic % nitrogen in molybdenum. Author

**N69-13059*#** Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.

**SOLAR-RADIATION-INCUDED DAMAGE TO OPTICAL PROPERTIES OF ZnO-TYPE PIGMENTS Technical Summary Report, Jul. 1966-Feb. 1968**

A. F. Skiensky, H. F. MacMillan, and S. A. Greenberg Feb. 1968 177 p refs
(Contract NAS8-18114)
(NASA-CR-98174; Rept-4-17-68-1) Avail: CFSTI CSCL 11C

The majority of the experimental work involved studying the optical properties in situ. A device was specially constructed to monitor the optical properties in vacuum, and under irradiation. Two spectral regions of damage occur in ZnO; in the visible and IR regions. This latter damage region was found to be highly pressure dependent. Large damage observed in situ recovers completely upon exposure of the sample to oxygen. A number of experiments were performed to elucidate the mechanism of damage for each region. The parameters varied included temperature, intensity of irradiation, pressure of oxygen, and energy of incident photons. The ESR and electrical properties measurements provided supplementary information. Single crystals of ZnO were also studied. With reasonable confidence the UV induced IR absorption is attributed to excitation from bound donor states associated with oxygen vacancies. The induced visible absorption is tentatively assigned to defect states or to lattice strain. Introduction of acceptors should inhibit or prevent the damage both by acting as hole traps and by reducing the occupancy of oxygen vacancy defect states, or adsorbed oxygen states. The acceptor Cu was introduced into the lattice and significant infrared stabilization did occur. Experiments were performed to characterize the effect of the dopant. Author

**N69-13082#** Fabrique Nationale d'Armes de Guerre, Herstal-lez-Liège (Belgium). Laboratoire Central.

**UDIMET 500. THE INFLUENCE ON CREEP STRENGTH OF THE HEAT TREATMENT PERFORMED DURING CREEP TESTS [UDIMET 500. INFLUENCE SUR LA RESISTANCE AU FLUAGE D'UN TRAITEMENT THERMIQUE EFFECTUE EN COURS DE FLUAGE]**

C. Dupont 30 Jun. 1967 18 p In FRENCH *Its* Serial No. 3970
Avail: CFSTI

It has already been shown that heat treatment of U-500 carried out during creep tests at 900°C/17.8 kg/mm$^2$ can improve the life of test bars. In this work the results of further tests carried out at different temperatures and under different loads are given. The increase of grain size is discussed in relation to these phenomena. ESRO

**N69-13085#** Kernforschungsanlage, Juelich (West Germany)

**INTERNATIONAL CONFERENCE ON VACANCIES AND INTERSTITIALS IN METALS**

Sep. 1968 487 p refs Conf. held 23-28 Sep. 1968
(JUEL-CONF-2-Vol-1) Avail: CFSTI

Presented conference papers cover fundamental problems of point defect phenomena in metals with emphasis on defect identification and interpretation of the annealing stages. Particular attention is focused on reviewing equilibrium, quenching, irradiation, and plastic deformation experiments. For individual titles see N69-13086 through N69-13120.

N69-13086# Academy of Sciences (USSR), Moscow. Inst. for High Temperatures.

**FORMATION ENERGY OF HEAT VACANCIES IN MOLYBDENUM AND THEIR CONCENTRATION**

V. Ya. Chekhovskoy and V. A. Petrov *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 6–18 refs (See N69-13085 03-17)

Avail: CFSTI

Formation energy of vacancies in molybdenum-1.86 formation entropy of vacancies −7.8 and dependence of heat vacancies concentration on temperature have been for the first time calculated on the basis of experimental data on enthalpy of molybdenum obtained by "drop method" for temperature range of 1000–2850°K. The vacancies concentration at the molybdenum melting point has been found to amount to 2.9%. The results obtained are compared with the data calculated by other authors, on the basis of data on trueheat capacity of molybdenum at high temperatures. Author

N69-13088# Chalmers Univ. of Technology, Gotsborg (Sweden). Dept. of Physics.

**SELF-DIFFUSION AND IMPURITY DIFFUSION IN LITHIUM**

A. Ott and A. Lodding *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 34–54 refs (See N69-13085 03-17)

Avail: CFSTI

The diffusion of ten different metallic tracers in lithium metal has been investigated. The diffusion coefficients, extrapolated to the m.p., range between about $10^{-8}$ and $10^{-5}$ cm$^2$/sec, with the self-diffusion value just above $10^{-7}$. The activation energies (in kcal/mole) are: $Q_{Li}$=12.6; $Q_{Na}$=12.6; $Q_{Ag}$=12.9; $Q_{Au}$=10.5; $Q_{Zn}$=13.0; $Q_{Cd}$=16.1; $Q_{Hg}$=14.5; $Q_{Ga}$=12.7; $Q_{In}$=15.9; $Q_{Sn}$=13.6. The activation energy found for the $^6$Li tracer lies about half-way between the differing results of earlier self-diffusion measurements, and satisfies the same empirical rules as other alkali metals. No satisfactory explanation of the impurity diffusion results is provided by any existing theory. The importance of ion core difference between impurity and matrix atoms appears greatly to outweigh that of valency differences. Another insufficiently understood result has been obtained in inter-diffusion of Li tracer in isotopically separated lithium: the diffusivity in $^6$Li matrix is by some 20% lower than in $^7$Li. Author

N69-13092# York Univ. (England). Dept. of Physics.

**SUSTAINED VACANCY SUPERSATURATION IN METALS AND ALLOYS**

D. A. Blackburn and J. Bleay *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 82–90 refs (See N69-13085 03-17)

Avail: CFSTI

The constituents of an alloy subject to a temperature gradient do not move randomly but drift parallel to the gradient. It is shown that this flow may cause perturbations of the vacancy concentration of magnitude comparable with those produced in the Kirkendall effect, and that this effect may be greatly increased when an electric current flows parallel to the temperature gradient. Equations of vacancy flow, based on the assumption of equilibrium, are shown to be in error at lower temperatures in the diffusion range. Author

N69-13093# Israel Atomic Energy Commission, Beersheba. Nuclear Research Centre.

**DIFFUSION OF COBALT AND OF GOLD IN dhcp AND IN bcc PRASEODYMIUM**

M. P. Dariel, G. Erez, and G. M. J. Schmidt (Weizmann Inst. of Sci.) *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 91–104 refs (See N69-13085 03-17)

Avail: CFSTI

The thin-layer sectioning technique has been used to measure the diffusion of cobalt and of gold in dhcp and bcc praseodymium. The diffusivities can be expressed as $D_{Au}$/dhcp Pr = $4.3\times10^{-2}$ exp [−0.85 eV/kT] cm$^2$/sec; $D_{Au}$/bcc Pr = $3.3\times10^{-2}$ exp [−0.87 eV/kT] cm$^2$/sec; $D_{Co}$/dhcp Pr = $4.7\times10^{-2}$ exp [−0.79 eV/kT] cm$^2$/sec. The results are several orders of magnitude higher than the self-diffusion coefficients of praseodymium. They are interpreted as being due to a diffusion mechanism in which solutes in interstitial positions play the predominant role. Author

N69-13095# Washington Univ., Seattle. Div. of Metallurgical Engineering.

**VACANCIES IN GOLD**

H. I. Dawson and K. B. Das *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 125–139 refs (See N69-13085 03-17)

Avail: CFSTI

Electrical resistivity recovery spectra of lattice defects in 99.9999 and 99.99% pure gold have been determined between −20° and +170°C. Defect structures were produced by quenching, quenching followed by deformation, and by deformation. An extensive recovery spectrum with a characteristic substructure is observed in all cases. Most of the defect resistivity of quenched gold recovers between 35° and 125°C. In this range three processes are observed which shift to lower temperatures with increasing quenching temperature, impurity concentration, and dislocation density. It is suggested that these could be due to tri-, di-, and single vacancies respectively. The recovery below 35°C and above 125°C is enhanced by impurities; some small vacancy cluster nucleated at impurities during the quench, could become mobile, below 35°C, while the recovery above 125°C could be due to the release of impurity trapped vacancies. A comparison of the recovery spectrum of deformed gold with these results indicates that most of the recovery in Stage III could be due to small vacancy clusters, divacancies, and single vacancies, while Stage IV could be caused by the release of trapped vacancies. Author

N69-13096# Birmingham Univ. (England). Dept. of Physical Metallurgy and Science of Materials.

**THE HETEROGENEOUS NUCLEATION OF TETRAHEDRA IN QUENCHED GOLD**

I. A. Johnston, P. S. Dobson, and R. E. Smallman *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 140–153 refs (See N69-13085 03-17)

Avail: CFSTI

The influence of copper and magnesium impurities on the defect structure of quenched gold has been studied by electron microscopy. The magnesium additions resulted in an increase in the tetrahedra density but with higher impurity concentrations the nucleation of tetrahedra was suppressed in favour of dislocation loops. The efficiency of the impurities in promoting heterogeneous nucleation was much greater for magnesium where the observed effects were observed with concentration of the order of parts per million whereas larger concentrations of copper of the order of a few percent are required. From these results together with those of other workers it is concluded that divalent impurities are more efficient as nucleating agents than monovalent impurities. These conclusions are accounted for by a model in which divacancy-impurity atom interactions lead to enhanced tetravacancy formation because

of attractive interactions between free and trapped divacancies, and the model also accounts for loop formation when a high impurity concentration is present. Author

N69-13097# Parma Univ. (Italy).
**VACANCY–IMPURITY ATOM INTERACTION IN AU-PT DILUTE ALLOY**
A. Camanzi, N. A. Mancini (Catania Univ.), E. Rimini (Catania Univ.), and G. Schianchi *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 154–166 refs (See N69-13085 03-17)
Avail: CFSTI

An experimental investigation has been carried out on vacancy-impurity atom interaction in Au+1 at% Pt alloy by quenching and aging experiments and by electron-microscope observations. A similar investigation has been carried out in 99.999% pure Au. From the experimental results obtained it is possible to confirm that the interaction between the Pt atom and the vacancy is repulsive. The difference between the activation energy for formation of vacancies in Au+lat.%Pt and in 99.999 Au is $+0.13 \pm 0.04$ eV, while the difference between the activation energy for vacancy migration is $-0.08 \pm 0.04$ eV. In the electron microscope observations a higher number of faulted loops are found in the Au+lat.% Pt specimens than in 99.999 Au specimens. Author

N69-13098# Ecole National Supérieure de la Métallurgie et de l'Industrie des Mines, Nancy (France). Laboratoire de Physique du Solide.
**THE STUDY OF DEFECTS IN QUENCHED NICKEL**
S. Scherrer, G. Lozes, and B. Deviot *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 167–175 refs (See N69-13085 03-17)
Avail: CFSTI

Quenched nickel wires are investigated by electrical resistivity measurements and transmission electrons microscopy. Isochronal annealing curves show 3 stages centered about 60°C, 280°C and 540°C whose activation energies correspond to 0.85 eV, 1.40 eV and 2.2 eV respectively. A dependence of the recovery of these stages is observed. In less pure nickel the amplitude of the last stage is much larger than the preceding two stages. It seems that in nickel of lower purity, clusters form during quench which, for higher purity nickel, are mostly formed during the anneal that occurs in the preceding two stages. This is consistent with the result of electronic microscopy. Author

N69-13100# Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.
**THE EFFECTS OF INDIUM ON THE RECOVERY OF QUENCHED-IN VACANCIES IN ZONE-REFINED ALUMINIUM**
F. C. Duckworth, T. R. Ramachandran (Univ. Coll. of Swansea), and J. Burke (Univ. Coll. of Swansea) *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 185–199 refs (See N69-13085 03-17)
Avail: CFSTI

The recovery of quenched-in vacancies in a number of aluminium-indium alloys based upon zone-refined aluminium has been studied using resistivity measurements and transmission electron microscopy. Recovery is shown to occur in three stages: (a) solute-vacancy association, (b) the formation of prismatic dislocation loops, and (c) the annealing out of the loops. The kinetics of the first stage are analysed and for low quench temperatures found to be consistent with a modified Damask and Dienes theory. Consideration is given to the possibility of solute-vacancy association occurring during quenching. From loop density measurements the indium-vacancy binding energy is roughly estimated to be 0.27eV. Author

N69-13101# Melbourne Univ., Parkville (Australia).
**FAULT CLIMB DURING GROWTH OF FRANK LOOPS IN QUENCHED SILVER AND COPPER-ALUMINIUM ALLOYS**
L. M. Clarebrough and A. J. Morton *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 200–214 refs (See N69-13085 03-17)
Avail: CFSTI

The Burgers vectors of the dislocations, bordering steps in the stacking fault in Frank dislocation loops in quenched silver and copper-aluminium alloys, have been identified by comparison of experimental images and images computed using the Head-Humble technique. Similar comparisons show that the edges of Frank dislocation loops in these materials are dissociated. Dissociation of the edges of loops, once aligned along (110), hinders growth of the loops at the edges by simple vacancy addition, and growth continues by climb of the stacking fault. Fault climb is compatible with the observed Burgers vectors and particular configurations of the loops. Author

N69-13102# Wake Forest Coll., Winston-Salem, N. C.
**THE ANNEALING KINETICS OF QUENCHED SILVER-GOLD ALLOY WIRES**
G. P. Williams, Jr., B. J. Klein, and J. Everett *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 215–227 refs Supported in Part by AEC (See N69-13085 03-17)
Avail: CFSTI

The annealing kinetics of quenched silver-gold wires have been investigated across the entire concentration range of solid solutions. Immediately after the quench an initial increase in resistance which is attributed to the onset of short range order has been observed, followed by a decrease in resistance which is associated with the annihilation of vacancies. The same activation energy is calculated for the ordering and the annihilation processes, and has a minimum at approximately 50 at% gold. The defect is tentatively identified as a single vacancy and the number of vacancy jumps calculated for the completion of the process is consistent with the two mechanisms proposed. Author

N69-13103# Michigan State Univ., East Lansing. Dept. of Physics.
**QUENCHING PLATINUM AND TUNGSTEN IN SUPERFLUID HELIUM**
Ronald Gripshover, John Zetts, and Jack Bass *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 228–234 refs (See N69-13085 03-17)
Avail: CFSTI

We are quenching platinum wires into various liquids and in superfluid helium, and tungsten wires in superfluid helium. At high temperatures the resistivities quenched into fine platinum wires cooled in superfluid helium are consistent with those quenched into larger wires plunged into water and kerosene. However there is reason to believe that the platinum and helium interact in a manner which does affect the results obtained. The resistivities quenched into high purity 0.001" and 0.0012" diam tungsten wires ($R_{273°K}/R_{4.2°K} > 600$) are comparable to Schultz's published results. However some differences do exist. Author

N69-13104# Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires.
**VACANCIES IN GOLD AND MATTHIESSEN'S RULE**
R. R. Conte, J. Durel, and Y. Quéré *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 235–239 refs (See N69-13085 03-17)
Avail: CFSTI

Deviations to Matthiessen's rule have been observed for vacancies in gold. These deviations are consistent with a decrease of the Debye temperature. Author

N69-13106# Atomics International, Canoga Park, Calif.
**THE STAGE 3 RECOVERY IN ELECTRON-IRRADIATED ALUMINUM**
W. Bauer *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 275–289 refs (See N69-13085 03-17)
Avail: CFSTI

We have studied the irradiation-produced resistivity recovery of 99.9999% pure annealed and prequenched aluminum foils. The prequenched specimen exhibited two distinct recovery peaks, at 245°K and 320°K (Stage IV), whereas the unquenched specimen exhibited only one peak at 255°K (Stage III). The activation energy of the Stage III recovery, analyzed by the Meechan–Brinkman method, was found to be 0.58 eV. The order of reaction kinetics was found to be a function of the recovery. The implications of these results on existing recovery models are discussed. Author

N69-13107# Centre d'Etudes de Chimie Metallurgique, Vitry (France).
**INTERACTION OF POINT DEFECTS WITH MAGNESIUM IMPURITY ATOMS IN NEUTRON–IRRADIATED ALUMINIUM**
C. Dimitrov–Frois and O. Dimitrov *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 290–303 refs (See N69-13085 03-17)
Avail: CFSTI

The recovery of electrical resistivity of a series of aluminium–magnesium alloys ($\leq 0.3.10^{-6}$ to $3200.10^{-6}$ atomic) has been studied after neutron irradiation at 78°K to doses of a few $10^{17}$ n/cm$^2$. The presence of magnesium produces a considerable increase of stage II recovery, up to a constant value which is reached for concentrations higher than $1000.10^{-6}$. Stage III increases slowly without reaching a constant value, even for the highest concentration. A small stage III' appears just above stage III. The results are interpreted in terms of a model of interstitial-trapping by impurities, at 78°K, and detrapping in stage II. Author

N69-13108# Centre d'Etudes de Chimie Metallurgique, Vitry (France).
**ELIMINATION OF POINT DEFECTS IN NEUTRON-IRRADIATED ALUMINIUM DURING DEFORMATION AT 78 DEG K**
O. Dimitrov and C. Dimitrov–Frois *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 304–316 refs (See N69-13085 03-17)
Avail: CFSTI

Pure aluminium samples, neutron-irradiated at 78°K, have been deformed by compression at the same temperature. Deformation results in a decrease in low-temperature electrical resistivity, which corresponds to the elimination of a fraction of the radiation-induced defects which would recover in the range of stage III. This elimination is produced by the movement of dislocations through the metal. It is shown that the process involved is probably a destruction of interstitial clusters, freeing interstitial defects which disappear rapidly at the deformation temperature. Author

N69-13109# Japan Atomic Energy Research Inst., Ibaraki.
**EFFECT OF DEFORMATION ON THE RECOVERY OF NEUTRON IRRADIATED METALS**
S. Okuda, S. Takamura, and H. Maeta *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 317–326 refs (See N69-13085 03-17)
Avail: CFSTI

The recovery of point defects in F.C.C. metals after fast neutron irradiation at 15°K was studied by measurements of residual resistivity. Especially, the effect of cold work before and after low temperature irradiation on the recovery spectrum was studied. The results seem to show the annealing of interstitial clusters in stage II in cold worked Cu. Author

N69-13110# Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires.
**STUDY OF STAGE 1 IN IRRADIATED NICKEL**
G. de Keating-Hart, R. Cope, C. Minier, and P. Moser *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 327–338 refs (See N69-13085 03-17)
Avail: CFSTI

Resistivity and internal friction measurements are reported for the I recovery stage of electron irradiated, monocrystalline nickel samples of high purity. Results indicate that applied magnetic fields suppressed internal friction peaks by a change in magnetization orientation and that the electron bombardment direction has a distinct influence on the percentage of different recovery stages. Stage $I_C$ shows an increase in the numbers of closed pairs by bombardment in the direction $<100>$. The author proposes an internal friction model compatible with observed resistivity and magnetic effects. G.G.

N69-13111# Technische Hochschule, Darmstadt (West Germany).
**EFFECT OF ANNEALING ON THE LATTICE PARAMETER OF NEUTRON-IRRADIATED ALUMINIUM AND COPPER**
U. Himmler, H. Peisl, A. Sepp, W. Waidelich, and W. Wenzl (Tech. Hochschule Munchen) *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 343–354 refs (See N69-13085 03-17)
Avail: CFSTI

Pure aluminium and copper crystals were irradiated in the low-temperature irradiation facility of the Munich Research Reactor at 4.6°K. After irradiation and thermal annealing lattice parameter change was measured. In aluminium recovery stages equivalent to that known from electrical resistivity, length and stored energy measurements were observed. In copper four recovery stages were resolved. Author

N69-13113# Kernforschungsanlage, Juelich (West Germany).
**COMBINED MEASUREMENTS OF ELECTRICAL RESISTIVITY AND YOUNG'S MODULUS IN ELECTRON IRRADIATED COPPER**
G. Roth and V. Naundorf (Technischen Hochschule Aachen) *In its* Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 364–376 refs (See N69-13085 03-17)
Avail: CFSTI

Pairs of copper samples—one for electrical resistivity, the other for Young's modulus measurements—were irradiated simultaneously at 120°K with 3 MeV electrons up to an integrated dose of $2\times10^{20}$e/cm$^2$. The effect of dislocation pinning and the bulk effect of point defects on Young's modulus E could clearly be separated. The following relation between the bulk effect $\Delta E/E$ and the Frenkel defect concentration $c_F$ was found: $\Delta E/E = -75\ c_F$. Besides strong annealing in stages II and III (180–300 K) and some annealing between 300–500°K, stage V annealing (500–600°K) also was observed. In stage III the resistivity annealed more than Young's modulus, whereas the converse occured in stage V. These measurements are discussed in connection with the electron microscopical observation of point defect clusters after electron irradiation at 120°K and heating to room temperature. Author

N69-13114# Commissariat a l'Energie Atomique, Grenoble (France).
**ELECTRON IRRADIATED PURE NICKEL OBSERVED BY ELECTRON MICROSCOPY**
A. Bourret *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 377–390 refs (See N69-13085 03-17)
Avail: CFSTI

Irradiation of pure nickel foils was carried out between −40°C and +10°C in vacuum ($10^{-5}$ Torr) with 2 or 3 MeV electrons. Subsequently observed "black dots" are interstitial Frank dislocation loops. There is a well defined critical dose above which agglomerates are visible. The existence of a critical dose gives valuable information about the agglomeration process. These results prove that an interstitial defect is mobile below stage III. In the stage III temperature range there is a visible agglomeration of interstitials which is interpreted either as a diffusion of loops by pipe diffusion or by diffusion of another interstitial-type defect. Author

**N69-13115#** Kernforschungsanlage, Juelich (West Germany).
**ELECTRON MICROSCOPE STUDIES OF POINT DEFECT CLUSTERS IN ELECTRON IRRADIATED COPPER**
G. P. Scheidler and G. Roth *In its* Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 391–404 refs (See N69-13085 03-17)
Avail: CFSTI

Transmission electron microscopy has been used to measure the density and size distribution of visible defect clusters at 20°C in electron irradiated copper as a function of electron dose, irradiation temperature and impurity content. At a irradiation temperature of 120°K, the cluster density is nearly proportional to the Frenkel-pair concentration introduced by the irradiation. The cluster density decreases more rapidly with increasing irradiation temperature up to 230°K than it does above this temperature. A comparison of pure (99.999) and impure (99.99) copper at 120°K gave the same cluster densities and size distributions whereas at 230°K the impure material showed a much higher density but with smaller average size of clusters than the purer material. Comparison of neutron irradiated copper with electron irradiated copper indicates that in the former, displacement cascades are an important mechanism leading to cluster formation. Author

**N69-13116#** Technische Hochschule Munchen (West Germany). Physik-Department.
**INFLUENCE OF IRRADIATION-INDUCED DEFECTS IN ALUMINIUM AND COPPER ON HALL EFFECT, MAGNETORESISTANCE AND DEVIATIONS FROM MATTHIESSEN'S RULE**
K. Boening, B. Langeler, J.-M. Welter, and H. Wenzl *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 405–419 refs (See N69-13085 03-17)
Avail: CFSTI

The Hall effect R, magnetoresistance m and deviations d from Matthiessen's rule were measured in pure Aluminium and Copper after neutron irradiation at 4.6°K and during annealing. Since the values of R, m and d sensitively depend on the defect type and are nearly independent of the defect concentration, they could be used to investigate changes of defect configurations during irradiation and annealing which do not show up in the residual electrical resistivity. Author

**N69-13117#** Tubingen Univ. (West Germany). Institut fuer Angewandte Physik.
**RADIATION DAMAGE IN THIN FILMS CAUSED DURING THEIR VACUUM DEPOSITION BY IRRADIATING WITH IONS OF THE EVAPORATION MATERIAL**
E. F. Krimmel *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 420–426 refs (See N69-13085 03-17)
Avail: CFSTI

Radiation damage is caused in thin films during their vacuum deposition by fast and monoenergetic ions of the evaporation material. The films with uniform thickness over an area of more than 10 $cm^2$ contain a high and nearly constant damage rate throughout the total volume. Films of Cu, Au, Pt, Ni, Cr, Nb, Pt–Ir, Au–Cr and Fe–Cr deposited at room temperature and exceeding a critical thickness show radiation hardening. Depending on the thickness of the film, sharp and pronounced annealing peaks of the electric resistivity were observed with Au, Pt, Cr and Ni whereby Au and Pt films became soft but Cr and Ni films did not change their mechanical hardness. The surface of the films acts as a sink for the lattice defects. No radiation hardening was observed with Al and Ag. Author

**N69-13118#** Kyoto Univ. (Japan). Dept. of Metal Science and Technology.
**RECOVERY STAGES IN DEFORMED PLATINUM**
Sei Miura, Jin-Ichi Takamura, and Nobuo Ogasa *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 429–443 refs (See N69-13085 03-17)
Avail: CFSTI

Recovery stages, and in particular stages III and IV are studied by resistivity measurements on platinum polycrystals deformed at −195°C. Two sub-stages have been found in stage III, on 10 min/20°C and from 100°C to 160°C. The former pronounced sub-stage with the activation energy of about 0.7 eV is ascribed to the annihilation of normal interstitials to vacancies as well as the annihilation to dislocations, while the latter weak sub-stage with the energy of about 1.1 eV is due to the annihilation of divacancies to dislocations. It is also shown that single vacancies are annihilated to dislocations at stage IV with the energy of about 1.4 eV. Author

**N69-13119#** Ludwig-Maximilians-Universitat, Munich (West Germany).
**MATTHIESSEN'S RULE AND THE ANALYSIS OF ANNEALING DATA FROM COLD WORKED PLATINUM**
K. Roesch, F. Beil, and R. Sizmann *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 444–455 refs (See N69-13085 03-17)
Avail: CFSTI

A recovery stage of cold-worked Pt centered about 250°C was analysed from resistivity measurement for the evaluation of the activation energy and the reaction order. For this, especially the influence of the measuring temperature of the electrical resistance was investigated. Although there is a remarkable violation of Matthiessen rule the apparent reaction order deduced from the measurements at 4.2°K and 77°K is almost the same. A critical review of the current techniques for the evaluation of the reaction order is made. The consequences are: (i) the activation energy has to be evaluated with reaction order independent methods, (ii) the formal reaction order should then be analysed from non-isothermal annealing data with the aid of the known activation energy. The recovery stage in Platinum is described by second order process and an activation energy of 1.35 eV. Author

**N69-13120#** Muenster Univ. (West Germany). Physikalisches Institut.
**SEPARATION OF ORIENTABLE POINT DEFECT ANNEALING FROM OTHER RECOVERY EFFECTS, USING ELECTRICAL RESISTIVITY AND MAGNETORESISTANCE DATA OBTAINED ON PLASTICALLY DEFORMED NICKEL**
W. Hellenthal and V. Lotter *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 456–468 refs (See N69-13085 03-17)
Avail: CFSTI

Isochronal annealing experiments in the recovery regions 3 and 4 were performed on nickel wires after low (up to 8%) plastic deformation, using measurements of electrical resistivity and magnetoresistance (in an alternating field of small amplitude). The latter method is shown to be very sensitive to recovery processes, thus revealing numerous details. Annealing the samples in different magnetic fields permitted a separation of orientable effects from other recovery contributions occurring simultaneously. The former could be attributed to interstitials (annealing with $E^{M}_{1}$ = (1.06

± 0.05)eV in region 4), stabilizing the magnetization locally by orientation resp. diffusion effects. For some temperature regions investigated, differentiations between recovery with a sequence of real primary substages and variations due to superposition of different types of processes resp. effects are shown to be possible. Author

**N69-13184#** Library of Congress, Washington, D. C. Aerospace Technology Div.
**DEVELOPMENT AND APPLICATIONS OF SOME SOVIET ALUMINUM ALLOYS**
Dimitri Vvedensky *In its* Foreign Sci. Bull., vol. 4, no. 12 Dec. 1968 p 35-43 refs (See N69-13181 03-34)
Avail: CFSTI

The physical and mechanical properties of some of the major aluminum alloys used in the Soviet aerospace industry are reviewed. Such basic alloys as Al-Zn-Mg, Al-Zn-Mg-Cu-Mn, and Al-Zn-Mg-Cu-Mn-Cr are discussed, and the improvement of properties through additions of Fe, Li, Cd, Ni, and Si is examined. Heat treatment, aging, and phase transition are considered for these alloys as well as their weldability, casting properties, and protective coatings. Sintered aluminum alloys are briefly mentioned. K.W.

**N69-13191** Virginia Univ., Charlottesville.
**A STUDY OF THE ADSORPTION OF OXYGEN ON COPPER (110), (100) AND (111) SURFACES WITH LOW ENERGY ELECTRON DIFFRACTION**
Gary Wayne Simmons (Ph.D. Thesis) 1967 180 p
Avail: Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-17621

The structural changes for clean copper (110), (100) and (111) surfaces when exposed to low pressures of oxygen were studied with low energy electron diffraction (LEED). Oxygen interaction was investigated for temperatures from room temperature to 750°C. These studies were supported by optical and electron microscopy of the reacted surfaces. A qualitative determination of the relative reaction rates for each of the (110), (100) and (111) surfaces was determined from the oxygen exposures required to produce observable changes in the LEED patterns. From this kinetic data, together with the structural changes in these surfaces as described below, a reasonable mechanism for the interaction of oxygen with copper was proposed. Dissert. Abstr.

**N69-13203*#** Aluminum Co. of America, New Kensington, Pa. Physical Metallurgy Div.
**STUDY OF CRACK-INITIATION PHENOMENA ASSOCIATED WITH STRESS CORROSION OF ALUMINUM ALLOYS Annual Report, 6 Jun. 1967-6 Jun. 1968**
M. S. Hunter and W. G. Fricke, Jr. 15 Jul. 1968 186 p refs
(Contract NAS8-20396)
(NASA-CR-98161; AR-2) Avail: CFSTI CSCL 11F

Structures of the added alloys, 7079-T6 and 7039-T6 were similar to that of 7075-T6 plate, both having unrecrystallized structures, uneven distribution of dispersoids, two sizes of boundary precipitates and a few dislocations. Microprobe analyses of surfaces containing stress corrosion cracks revealed an oxide type of reaction product containing chloride. Similar analyses in 7075-T6 revealed lower Zn and Mg than in the matrix, and in 2219-T37 revealed a definite association of microconstituent particles with mechanical fracture but not stress corrosion cracking. New electron fractographic methods showed that in 7075-T6, stress-corrosion cracks have relatively flat surfaces with small facets and with 2219-T37 the facets were much larger. Investigations of the effect of surface roughness showed that intergranular pre-corrosion in 7075-T6 leads to rapid crack initiation. Anodic and chemical surface films delayed but did not prevent crack initiation in 2219-T37 and 7075-T6, and a semi-logarithmic relationship was observed between stress level and crack initiation time. Author

**N69-13209*#** Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.
**A REVIEW OF THE LITERATURE ON PICKLING INHIBITORS AND CADMIUM ELECTROPLATING PROCESSES TO MINIMIZE HYDROGEN ABSORPTION BY ULTRAHIGH-STRENGTH STEELS**
T. P. Groeneveld, E. E. Fletcher, and A. R. Elsea 15 Nov. 1967 41 p refs
(Contract NAS8-20029)
(NASA-CR-98169) Avail: CFSTI CSCL 11F

This report describes the results of a literature and industrial survey of the available information on the effectiveness of inhibitors for reducing hydrogen absorption by steels during acid pickling and on additional low hydrogen embrittling and nonhydrogen embrittling cadmium electroplating processes. No attempt has been made to repeat the information on pickling inhibitors and cadmium electroplating processes presented in the previous reports. However, it was found desirable to include some reference to work described previously so as to provide necessary background information, to make desirable comparisons, and to be more complete in the discussions of certain processes. Author

**N69-13221#** Fulmer Research Inst., Ltd., Stoke Poges (England).
**ELECTRON BEAM PURIFICATION OF ALUMINA**
D. S. G. Davies Mar. 1968 49 p refs
(Contract KS/1/0286/CB 43A2)
(D-MAT-151) Avail: Issuing Activity

An electron beam zone melting process has been developed for the purification of alumina. Alumina comparable in purity with the best obtainable by other methods has been prepared and the technique is almost certainly capable of producing still purer material. The zone melted product takes the form of a thin sheet which is extensively cracked. Attempts at developing a method for re-melting the pure alumina into monolithic form have not been successfully concluded, but considerable progress has been made towards a method of producing large diameter pure sapphires. Author

**N69-13229*#** Whittaker Corp., West Concord, Mass. Nuclear Metals Div.
**PROPERTIES OF POWDERED TITANIUM ALLOYS**
Gerald Friedman Sep. 1968 36 p ref
(Contract NAS3-10301)
(NASA-CR-72469; NM-9902) Avail: CFSTI CSCL 11F

Titanium alloys Ti-6Al-4V and Ti-5Al-2.5Sn were converted to powder by four different techniques. The powders were compared with respect to chemical analysis, particle shape and size distribution, flow rate, and bulk density. Each powder was compacted in evacuated steel cans at three pressures and temperatures. The hot pressed compacts were compared with respect to chemical analysis, density, hardness, and mechanical properties in tension. Additional tensile tests were then performed on heat treated samples of low-oxygen-level compacts. Author

**N69-13260#** Bureau of Mines, Albany, Oreg.
**COLUMBIUM AND TANTALUM ALLOYS DEVELOPMENT**
Herbert R. Babitzke, Laurance L. Oden, and Hal J. Kelly Dec. 1968 16 p refs
(BM-RI-7211) Avail: Issuing Activity

As part of a project to develop refractory metal alloys suitable for high-temperature structural applications, solid solution and precipitation-hardening techniques were applied to columbium and tantalum alloys. Thirty-three alloys were evaluated to determine their formability, strength, and oxidation resistance. Three alloys had tensile strengths near 40,000 psi at 1,200° C: Cb-1N-5W-5V-10Hf (No. 4), Cb-15Hf-5W-0.5B (No. 31), and Cb-15Hf-5W-1B (No. 32).

Oxidation resistance of the high-strength alloys was good. Alloy 4 gained only 34 mg/cm$^2$ at 1,200° C, and 21 mg/cm$^2$ at 1,000° C in 2 hours. Hot forming was done without any protection from oxidation. Author

**N69-13279*#** Martin Co., Denver, Colo.
**INVESTIGATION OF LOW-TEMPERATURE CREEP IN TWO TITANIUM ALLOYS Final Report**
T. F. Kiefer and F. R. Schwartzberg Jun. 1967 49 p
(Contract NAS9-5842)
(NASA-CR-92418; MCR-67-221) Avail: CFSTI CSCL 11F

The creep behavior of 5Al–2.5Sn and 6Al–4V titanium alloys was characterized in various conditions at room and low temperatures. Results indicated the following observations: The Al–Sn alloy appears less resistant to the onset of creep than Al–V alloy. Two heats of Al–Sn titanium (both fine grained and annealed) exhibited wide variations in creep behavior, possible resulting from subtle microstructural variations. Coarse grained titanium appears to less resistant to creep than fine-grained material. Solution treatment and aging reduces the room temperature creep susceptibility of Al–V titanium. Creep in Al–Sn titanium occurs down to −110° F. Based on these results, allowable stress levels for these alloys should take into consideration time-dependent plastic deformation. The data suggest that for sustained load conditions a limiting stress of 85% of the yield strength for 6Al–4V and 70% to 80% of the yield strength for 5Al–2.5Sn be imposed. Author

**N69-13338#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**EXPERIMENTAL STUDY OF THE TOTAL HEMISPHERICAL EMISSIVITY, ELECTRICAL CONDUCTIVITY AND COEFFICIENTS OF THERMAL CONDUCTIVITY OF SEVERAL REFRACTORY METALS IN THE 1300–3000 DEG K RANGE [EKSPERIMENTAL'NOYE ISSLEDOVANIYE INTEGRAL'NOY POLUSFERICHESKOY STEPENI CHERNOTY, ELEKPROVOD-NOSTI I KOEFFITSIYENTA TEPLOPROVODNOSTI RYADA TUGOPLAVKIKH METALLOV V OBLASTI TEMPERATUR 1300–3000 DEG K]**
D. L. Timrot et al *In its* Internat. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 264–271 refs (See N69-13314 03-03)
(SM-74/224) Avail: CFSTI

Measurements were made of the coefficient of thermal conductivity, the total emissivity, and the electrical resistivity on refractory metals. Since the test range was above 1200 to 1300°K, the temperatures of the samples were measured with optical pyrometers or micropyrometers, of class 0.2 or 1.0, respectively. To measure sample temperatures, models of an absolute black body were used in the form of radial cylindrical cavities with diameters d = 0.8 to 1.2 mm and depth h = 5.6 mm; the effective emissivity of these cavities was of the order of 0.99. The tests were run in a vacuum of about 1 to 5 × 10$^{-5}$ mm Hg. The samples were heated by electron bombardment, which practically removed all limits on the level of the temperatures attainable in the experiment and allowed quantitative measurements of the energy transferred by the electrons to the specimen (in the experiments on determination of the thermal conductivity and total emissivity). Author

**N69-13358*#** Boeing Co., Seattle, Wash. Aerospace Group.
**A STUDY OF LOW-COST WELDMENTS IN PRESSURE VESSELS MADE OF HY-150 STEEL PLATES Final Report, 6 Jun. 1967–31 Oct. 1968**
C. F. Tiffany, J. N. Masters, D. L. Barclay, and R. E. Regan Oct. 1968 126 p refs
(Contract NAS3-10281)
(NASA-CR-72468; D2-114408-1) Avail: CFSTI CSCL 13H

Automated and manual weld procedures, gas compositions, and edge preparations were evaluated on 1.0-inch-thick plates of a 5Ni–Cr–Mo–V air melt steel. Tensile, conventional charpy, precracked charpy, single edge notch, and surface flawed fracture specimens were tested to determine parameters that would produce low cost welds with a minimum plain strain fracture toughness of 200 ksi. From results of these and of five vessel cyclic and burst tests, it was demonstrated that this alloy, assembled with a combination of flame-cut edges, covered electrode, and gas metal arc welding procedures, is capable of meeting a leak-before-failure design criteria for 260-inch-diameter motor cases. Author

**N69-13362#** Northwestern Univ., Evanston, Ill. Dept. of Materials Science.
**A STUDY OF THE RELATIVE DUCTILITIES OF TiFe, TiCo, AND TiNi**
R. Scholl, David J. Larson, Jr., and E. J. Freise Mar. 1968 25 p refs
(Contract Nonr-1228(31))
(AD-676879; TR-1) Avail: CFSTI CSCL 11/6

A study of the relative ductilities of binary and ternary compounds of the type TiX where X is Fe, Ni, Co or combinations of these, has been performed by means of three point bending tests at room temperature. The general results of these studies indicate that TiFe or TiCo form a continuous series of solid solutions with TiNi provided the concentration of titanium remains at 50 atomic percent. The ductility of the binary compounds increases in the order TiFe, TiCo, TiNi. Also, nickel additions to TiFe and TiCo increase their relative ductilities. Author (TAB)

**N69-13364#** National Bureau of Standards, Washington, D. C. Metallurgy Div.
**THE NBS ALLOY DATA CENTER: FUNCTION, BIBLIOGRAPHIC SYSTEM, RELATED DATA CENTERS, AND REFERENCE BOOKS**
Gesina C. Carter, L. H. Bennett, J. R. Cuthill, and D. J. Kahan Aug. 1968 197 p refs
(NBS-TN-484) Avail: SOD $1.25

The Alloy Data Center, part of the National Standard Reference Data System, has two primary functions. One is to stimulate cooperation and coordination among the existing data centers in the area of the physical properties of well characterized alloys. The final data generated by these centers for publication should be consistent with one another where correlation or possible overlap exists. The other purpose is the collection (from publications as well as private communications), evaluation, and publication of data in some areas where special competence exists in the Alloy Physics Section. Of interest to the center are metals, semimetals, intermetallic compounds, and alloys. Excluded are those materials which have ill-defined constitutions and heat treatments. An automated system has been developed to meet the bibliographic needs of the center. This system will be described as well as the specific properties of interest. The system presently contains a complete annotated file on papers dealing with NMR Knight shift measurements. The soft X-ray spectroscopy compilation is being kept up-to-date with the same system. Author

**N69-13388#** Fabrique Nationale d'Armes de Guerre, Herstal-lez-Liege (Belgium). Laboratoire Central.
**THE DETERMINATION OF THE RETAINED AUSTENITE IN STEELS BY X-RAY DIFFRACTION: APPLICATION TO THE CEMENTED Cr-Ni-Mo STEEL [DOSAGE DE L'AUSTENITE RESIDUELLE DANS LES ACIERS PAR DIFFRACTION DE RAYONS X: APPLICATION A L'ACIER Cr-Ni-Mo CEMENTE]**
J. Hontoir 25 Oct. 1967 25 p In FRENCH *Its* Serial No. 4047
Avail: CFSTI

The theoretical basis of the determination of retained austenite in austenite steel by X-ray diffraction is explained. Several methods are proposed, e.g., R-coefficient method, micrographic gaging, standard gaging, self-gaging, and their advantages and disadvantages are discussed. The results obtained with case-hardened steel are given. The R-coefficient method appears to produce results that are systematically too small whereas the self-gaging method seems more reliable. ESRO

**N69-13389#** Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.

**LOW TEMPERATURE ELECTRON IRRADIATION STUDIES IN METALS**

C. M. Jimenez, L. F. Lowe, and E. A. Burke Jul. 1968 22 p refs *Its* Phys. Sci. Res. Paper No. 359

(AD-676794; AFCRL-68-0377) Avail: CFSTI CSCL 11/6

Polycrystalline platinum and palladium were bombarded with monoenergetic electrons at temperatures below 9 K. Changes in electrical resistivity R(E) = delta rho/electron-sq cm were measured in the energy range 1.1 to 3.0 MeV. The experimental values found in this interval are consistent with displacement threshold energies of 37 eV for Pt and 34 eV for Pd. The resistivities per unit defect concentration were found to be 0.00075 and 0.0009 ohm-cm for Pt and Pd respectively. The threshold energies found here, together with values reported for other face centered cubic elements, are shown to be directly proportional to atomic number and inversely proportional to the lattice parameter. It is also shown that the resistivities per unit defect concentration can be correlated with the resistivity at 0C. Analysis of the energy dependence of the damage production indicates atomic displacement cascades are markedly inhibited, which is consistent with deuteron damage studies. Alternative multiple displacement models and possible mechanisms are discussed. Author (TAB)

**N69-13402#** Fabrique Nationale d'Armes de Guerre, Herstal-lez-Liège (Belgium). Laboratoire Central.

**UDIMET 700: THE PHASE SOLUTION AND THE TENDENCY FOR AN INCREASE IN THE GRAIN SIZE [UDIMET 700: MISE EN SOLUTION ET PROPENSION AU GROSSISSEMENT DU GRAIN]**

C. Dupont 4 Aug. 1967 25 p In FRENCH *Its* Serial No. 3978

Avail: CFSTI

The structure of U-700 as it comes from the factory is analyzed. The temperature and the time of heating required to obtain a complete phase solution and the effects on grain size and hardness of the alloy are discussed. ESRO

**N69-13456#** European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.

**GAMMA PHASE URANIUM-MOLYBDENUM FUEL ALLOYS**

G. Beghi Brussels Sep. 1968 81 p refs

(EUR-4053.e) Avail: CFSTI

Available information on gamma phase uranium molybdenum alloys, mainly the U-10 wt% alloy, is summarized. The bibliographic review includes data up to January 31, 1967. Gamma stability characteristics were gathered based on thermal transformation kinetics (TTT diagrams) of the metastable gamma phase. Dimensional stability of the alloys under thermal cycling and under irradiation was studied from the results of several irradiation experiments. These results related to radiation induced phase reversal and swelling. Physical and mechanical properties as observed by different authors are also included. Author

**N69-13457#** European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.

**FORMATION OF ALLOYS BETWEEN LOW AND HIGH MELTING METALS BY THE REDUCTION OF VOLATILE METAL HALIDES AND CLARIFICATION OF THE COMPOSITION OF THE ALLOYS OBTAINED BY THIS PROCESS [LEGIERUNGSBILDUNG ZWISCHEN NIEDRIGUND HOCHSTSCHMELZENDEN METALLEN DURCH REDUKTION FLUCHTIGER METALLHALOGENIDE UND KLARUNG DES AUFBAUS DER SO ERHALTENEN LEGIERUNGEN]**

Th. Heumann (Universitaet Muenster) and H. Venker Brussels Jul. 1963 76 p refs In ITALIAN; ENGLISH summary

(EUR-4041.d) Avail: CFSTI

A process is described for the preparation of alloys of metals with a widely different melting-point. Volatile halogenides of the high-melting-point component are passed through the liquid low-melting-point metal, where they are reduced. Author

**N69-13505#** Bhabha Atomic Research Centar, Bombay (India). Metallurgy Div.

**STUDIES IN THE CORROSION OF ALUMINUM BASE ALLOYS IN WATER AT VARIOUS pH VALUES. PART 1: CORROSION OF ALUMINUM BASE NICKEL, SILICON, AND MAGNESIUM ALLOYS**

P. R. Shibad, N. S. D. Elayathu, and J. Balachandra 1968 12 p refs

(BARC-334) Avail: CFSTI

The influence of pH on the corrosion of aluminum base nickel, silicon alloy with and without magnesium in water of pH 5, 6.5 and 8 at 30°, 85° and 100° C has been studied by weight loss and electrochemical methods. The Al-9% Si-1% Ni alloy has better corrosion resistance than Al-9% Si-1% Ni-1% Mg alloy at the pH values and the temperatures reported. The corrosion rate is found to be maximum at pH8 at these temperatures for both the alloys. The results obtained have been compared with corrosion behaviour of aluminum 1S in water at various pH values and temperatures. Author

**N69-13546#** General Electric Co., Schenectady, N. Y. Research and Development Center.

**FERROMAGNETIC DOMAIN STUDIES IN HIGHLY PERFECT METAL PLATELETS Final Report, 1 Jun. 1967–31 May 1968**

Ralph W. DeBlois Sep. 1968 62 p refs

(Contract F19628-67-C-0332)

(AD-676792; S-68-1141; AFCRL-68-0414) Avail: CFSTI CSCL 11/6

Ferromagnetic domain and domain-wall structures and behavior, as observed in nearly perfect single-crystal platelets of nickel and nickel alloy, are the subject of the report. Results of primary interest are: (1) the formation of ferromagnetic domain structures in platelets is shown to be a micromagnetic process involving nucleation of Bloch lines, gradual variations in the directions of magnetization, magnetostatic interactions between domain walls, and topological constraints. (2) The structures of four kinds of stripe patterns have been determined. All involve magnetic moment rotations parallel to (110) planes, either through 109 degrees (for Stripe 1, which has pseudopositive anisotropy) or through 71 degrees. Stripe 4 achieves appreciable internal flux closure by forming a helical structure. (3) Data of domain wall type vs platelet thickness and composition have been plotted to show the regions of existence for Neel, crosstie, Bloch, and intermediate (metastable bright) walls, and for the four types of stripe structures. Author (TAB)

**N69-13558#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**APPARATUS FOR EXTRUSION OF METALS USING A HIGH PRESSURE FLUID [APPARATURA DLYA VYDAVLIVANIYA METALLOV ZHIDKOSTYU VYSOKOGO DAVLENIYA]**

E. D. Martynov, B. I. Beresnev, D. K. Bulychev, A. I. Evstyukhin, and K. P. Rodionov Nov. 1967 23 p refs Transl. into ENGLISH from Met. i Metalloved. Chistykh Met. (USSR), no. 5, 1966 p 173–188
(AD-676557; FTD-MT-24-271-67) Avail: CFSTI CSCL 11/6

The article gives design details of an extrusion apparatus; the article also gives detailed drawings of the extrusion die and the container. Author (TAB)

N69-13569# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INTERACTION OF SOLUTE ATOMS WITH DISLOCATIONS IN ALUMINUM-MAGNESIUM ALLOYS UNDER FATIGUE LOADING**
Chung-Kang Wang, Yuan-Shih Huang, and T'ing-Sui Ko Nov. 1967 18 p refs Transl. into ENGLISH from Wu Li Hsueh Pao (Peking), v. 21, no. 6, 1965 p 1253–1263
(AD-676568; FTD-HT-23-604-67) Avail: CFSTI CSCL 11/6

Torsional fatigue experiments were carried out with aluminum-magnesium alloys containing 0.52, 0.91, 3.46, and 5.15 per cent magnesium at the quenched state, and fatigue curves were determined. Experimental results showed that, in the cases of the specimens containing 0.52 per cent and 0.91 per cent magnesium, delta E drops with an increase of the stress cycle N when the torsion strain is small. However, when the torsion strain is higher, the curve keeps flat at the beginning, but delta E increases subsequently and becomes stable after a fairly high value is reached. As the magnesium content in the specimen is 3.46 per cent, the change of the delta E-N curve is similar to that of the Al-4 per cent Cu alloy when the torsion strain is not too high. When the torsion strain is sufficiently large, delta E increases at the beginning and decreases after it passes through a maximum value. The change of the delta E-N curve of the specimen containing 5.15 per cent magnesium is similar to that of the Al-4 per cent Cu alloy and no peak value was observed on the curve with the highest torsion strain. The Tm value shows an initial increase for specimens with all the magnesium contents studied. These results can all be explained with the assumption that atmospheres of solute atoms are formed because of the gradual migration of magnesium atoms to dislocations during fatigue loading. Author (TAB)

N69-13616# Israel Inst. of Tech., Haifa. Material Mechanics Lab.
**REPEATED DISCONTINUOUS YIELDING OF 2024 ALUMINUM ALLOY**
A. Rosen and S. R. Bodner Apr. 1968 39 p refs
(Contract AF 61(052)-951)
(AD-676291; MML-13; AFOSR-68-1936; SR-8) Avail: CFSTI CSCL 11/6

The repeated discontinuous yielding characteristics of 2024 aluminum alloy were determined for different conditions of solution and heat treatment and age hardening. The results are interpreted with reference to microscopic deformation mechanisms and the previously developed analysis of the mechanics of discontinuous yielding. Age hardening was found to suppress strain aging and thereby the occurrence of serrated yielding. The experimental results are in agreement with the predictions of the analysis of discontinuous yielding when it is generalized to include age hardening effects. Author (TAB)

N69-13639# Bhabha Atomic Research Centre, Bombay (India).
**STUDIES ON AQUEOUS CORROSION OF ZIRCONIUM AND ZIRCONIUM ALLOYS: REVIEW OF PRESENT STATUS**
P. S. Gadiyar 1968 45 p refs
(BARC-339) Avail: CFSTI

The attractive nuclear properties of zirconium render its alloys extremely interesting for the manufacture of sheathing fuel elements and pressure tubes. The basic alloys of zirconium have found mainly their application in the power reactors, cooled with water at temperatures around 300°C. The first part of this report deals with the review of the behaviour of unalloyed zirconium towards aqueous corrosion. The second part presents the development of corrosion-resistant high strength zirconium alloys such as zircaloys and zirconium-niobium alloys. The role of hydrogen produced during corrosion, the effects of irradiation and the various mechanisms proposed to explain the corrosion behaviour have been described in subsequent sections. Work undertaken at Trombay on the development of Zr-0.5% Nb-1% Cr alloy is also included. Author

N69-13660# Institut d'Optique Theorique et Appliquee, Paris (France).
**INVESTIGATION OF THE INFLUENCE OF DEFECTS IN THIN METALLIC FILMS Final Technical Report, 1 Jul. 1967–30 Jun. 1968**
Florian Abeles and M. L. Thaye Sep. 1968 30 p refs
(Contract DAJA37-67-C-0945)
(AD-676858) Avail: CFSTI CSCL 11/6

Thin gold films of various crystalline structures have been prepared by ultra-high vacuum evaporation and their optical properties were measured in the 0.5 to 6.2 range together with their DC resistivity. The optical mass m sub o was only slightly influenced by the defects (m sub o/m<1), whereas the optical relaxation time was strongly perturbed by them. The positions of the first two interband transitions are unmodified, their intensities decreasing with increasing defect concentration. A new absorption band sets in, centered at 1.4 or 1.7 eV according to the type of defect present in the film. Some possible mechanisms which might be responsible for it have been examined, but no definite conclusion could be reached. Author (TAB)

N69-13708# Tennessee Univ., Knoxville. Dept. of Chemical and Metallurgical Engineering.
**APPLICATION OF ADIABATIC CALORIMETRY TO METAL SYSTEMS Progress Report, 1 Sep. 1967–31 Aug. 1968**
E. E. Stansbury and C. R. Brooks Aug. 1968 21 p refs
(Contract AT(40-1)-3291)
(ORO-3291-8) Avail: CFSTI

Calorimetric methods and measurements used in the determination of the specific heat of metals and alloys are reviewed. Topics discussed include development of calorimetric standards and results of specific heat measurement on Al, Cu, Ni-base, Cr-Mo-Pd alloys and of Fe-Ni alloys. NSA

N69-13736# National Engineering Lab., Glasgow (Scotland).
**PRELIMINARY STUDY OF THE COEXTRUSION OF DISSIMILAR METALS**
E. Whitfield Jan. 1967 30 p refs
(NP-17505; NEL-265) Avail: CFSTI

A preliminary investigation has been made to ascertain the factors which govern the extrusion of rod, tube, and can from combinations of dissimilar metals. The results obtained showed that the flow of metal during coextrusion was dependent on the relative extrudabilities, disposition and dimensions of the dissimilar metals in the original billet, and on the die geometry. The coextrusion of rod appeared to be limited to metals of fairly similar extrusion characteristics and the loss of useful product owing to dissimilar flow appeared to be less if the billet was made such that the material of higher strength was wholly enclosed by that of the lower strength. No metallurgical bonding was achieved under the conditions of test at room temperature. Author (NSA)

N69-13768# Lockheed-California Co., Burbank.
**FRACTURE TOUGHNESS AND CRACK PROPAGATION OF 300 M STEEL**

S. L. Pendleberry, R. F. Simenz, and R. K. Walker Aug. 1968 256 p refs
(Contract FA-67-WA-1821)
(AD-676573; FAA-DS-68-18) Avail: Issuing Activity CSCL 11/6

Fracture toughness and crack propagation behavior was investigated for 300 M steel in sheet, plate and forging products. Variables included material thickness of 1/8, 3/8, and 3/4 inch and material strength levels of 220 KSI, 270 KSI, and 290 KSI. Both surface-crack and through-crack specimens were evaluated in moist air and salt water spray environments for cyclic stress ratios of +0.1, + 0.2, and +0.5. It was concluded that stress intensity methods showed promise for correlating both fracture toughness and cracking rate behaviors. There appears to be an inverse relationship between fracture toughness and cracking rate although a quantitative mathematical relationship between the two was not found. Variation in fracture toughness with heat chemistry was relatively large with respect to other metallurgical variables. Geometric variables included variations in fracture toughness with a/t ratio and variation of cracking rate with thickness. The influence of stress ratio on cracking rate was found to be accountable through available theory. Several approaches to MIL-HDBK-5 presentation of crack growth data are discussed. Author (TAB)

**N69-13767#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DISLOCATION DAMPING IN NICKEL-CARBON SOLID SOLUTIONS IN THE PROCESS OF PLASTIC DEFORMATION**
T'Ing-Sui Ko and Chao-Yuan Chang Nov. 1967 13 p refs Transl. into ENGLISH from Wu Li Hsueh Pao (Peking), v. 21, no. 1, 1965 p 154–160
(AD-676536; FTD-HT-23-603-67) Avail: CFSTI CSCL 11/6

Low frequency damping in the process of plastic deformation of nickel containing various amounts of carbon was measured on a small tensile testing machine. A series of internal friction peaks was observed on the internal friction-strain curve when the specimen contained a suitable amount of carbon. A study was made on the effect of heat treatment previous cold-working and temperature of measurement on this internal friction. It is suggested that the series of internal friction peaks is associated with the alternate anchoring of dislocations by atmospheres of solute atoms and their subsequent escaping in the course of plastic deformation. Author (TAB)

**N69-13799#** Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.
**THE INFLUENCE OF BORON ON ALPHA CRYSTALLIZATION OF URANIUM ALLOYS [INFLUENCE DU BORE SUR LA CRISTALLISATION $\alpha$ DES ALLIAGES D'URANIUM]**
Michel Foure, Jean-Pierre Lauque, Michel Colombie, and Jacques Decours Jul. 1968 34 p refs In FRENCH; ENGLISH summary
(CEA-R-3498)

This paper contains results of a research on alpha crystallization of uranium alloys. An addition of small quantities of boron produces an important refining of alpha grains for very small cooling rates (about 10–20°C/minute). This refining is due to the presence of $UB_2$ boride precipitation, acting as heterogeneous germs during the beta→alpha transformation. After a thorough study of alloys with small contents of molybdenum (0.2 to 0.4 % Mo) and an addition of $100 \cdot 10^{-6}$ of boron during isotherme and/or continuous cooling, the authors describe refining obtained for different alloys with very small contents (U-Si, U-Cr, U-Mo-Al, U-Mo-Si, U-Mo-Sn, etc.) and even for technical uranium, provided that boride precipitation is very thinly dispersed. Additions of very small quantities of boron do not modify mechanical properties. Author (ESRO)

**N69-13802#** Los Alamos Scientific Lab., N. Mex.
**CATHODIC VACUUM ETCHING WITH HYDROGEN**
R. D. Reiswig [1967] 7 p refs Presented at 22d AEC Metallography Group Meeting, San Diego, Calif.
(Contract W-7405-eng-36)
(LA-DC-9603; CONF-680614-3) Avail: CFSTI

The use of hydrogen has been found to produce superior results in the ion-bombardment etching of carbonaceous materials for optical microscopy. It appears that atomic, rather than molecular, hydrogen species are desirable for this purpose. In addition, this procedure may have some advantages in the etching of certain metals. Author (NSA)

**N69-13814#** Institutt for Atomenergi, Kjeller (Norway).
**CORROSION OF CARBON STEEL**
E. M. Hornsveld May 1968 27 p refs Prepared jointly with Reactor Centrum Nederland, Petten
(KR-127) Avail: CFSTI

The corrosion of carbon steel in water at 250°C with small amounts of oxygen has been studied in a boiling, out of pile loop made of carbon steel. In addition to the steel specimens activated iron was used in order to facilitate the investigation of corrosion product release and deposition. The corrosion rate of carbon steel in boiling high temperature water with about 0.1 ppM $O_2$ was 25 mg/dm$^2$/month after 3000 hours exposure and decreased to 10 mg/dm$^2$/month or less at 9000 hours. Slightly different start up conditions (mainly with respect to oxygen content) had a significant effect on the initial corrosion, but the corrosion rate at long exposure was little affected. The rate of release of corrosion products to the water was approximately 15 mg/dm$^2$/month at 3000 hours and dropped to a low value at 9000 hours, approximately 5 mg/dm$^2$/month. Author (NSA)

**N69-13822#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ELECTRIC PROPERTIES OF ALLOYS IN THE SYSTEM $CuInSe_2$–$In_2Se_3$ [DOSLIDZHENNYA ELEKTRYCHNYKH VLASTYVOSTEI SPLAVIV U SYSTEMI $CuInSe_2$–$In_2Se_3$]**
L. S. Palatnik, Yu. F. Komnik, V. M. Koshkin, L. P. Galchinetskii, and L. G. Manyukova Dec. 1967 18 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Ukrainian SSR), v. 9, no. 9, 1964 p 962–972
(AD-676529; FTD-HT-67-414) Avail: CFSTI CSCL 11/6

Elec. conds., thermal emfs., and Hall coeffs. of semiconducting alloys in the system CuInSe2-In2Se3 were measured to det. the dependence of thermal and optical forbidden zones, concns. of carriers, and the mobilities of electrons and holes on the compn. of the alloy. In a certain concn. range the alloys in this system are solid solns. having diamond-type crystal lattice. All alloys in this system which have a diamond crystal lattice are semiconductors. The compn. dependence curve of the width of the forbidden zone (delta E vs. In2Se3 concn.) passes through a min. in a concn. region which corresponds to the transition from the chalcopyrite to the sphalerite crystal lattice. The presence of the min. is attributed to the ordering effect in the cation sublattice of the alloys. Mechanisms of suppression of the elec. activity of impurities in semiconductors with stoichiometric lattice defects in the cation sublattice are discussed. The suppression starts in the presence of a small amt. of the defects, when the mobility of carriers is still considerable. The suppression of elec. activity of impurities in alloys is probably due to the fact that some atoms of the impurities penetrate the crystal defects and internodes and remain nonionized. Author (TAB)

**N69-13838#** Northwestern Univ., Evanston, Ill. Dept. of Materials Science.
**THE DEFORMATION MODES OF COBALT SILICIDES**
R. W. Sauer and E. J. Freise 1 Jul. 1968 27 p refs
(Contract Nonr-1228(31))
(AD-676882; TR-2) Avail: CFSTI CSCL 20/11

Coarse grained polycrystalline samples and single crystals of the cobalt silicides CoSi2, CoSi and Co2Si have been prepared from the elements. Deformation markings have been observed around hardness indentations in all compounds at room temperature. Author (TAB)

**N69-13850#** Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center.
**METALLURGICAL PROGRESS Quarterly Report, 1 Apr.–30 Jun. 1968**
30 Jun. 1968 62 p refs
(Contract AT(11-1)-599)
(USBM-RC-1347; QR-39) Avail: CFSTI

Developments are reported for studies on the preparation and properties of high melting point carbides: UC–UN–UO in production of high temperature reactor fuels; preparation and properties of W–Re–Mo alloys; preparation of high purity V by electrorefining; and the preparation of high purity Cr by the molten salt electrolytic technique. NSA

**N69-13864#** Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy.
**SOLIDIFICATION OF IRON BASE ALLOYS AT LARGE DEGREES OF UNDERCOOLING Final Report, 1 Oct. 1966–31 Dec. 1967**
M. C. Flemings, M. Myers, and W. E. Brower, Jr. Watertown, Mass. Army Mater. and Mech. Res. Center 15 Jul. 1968 92 p refs
(Contract DA-19-020-AMC-231(X))
(AD-676865; AMMRC-CR-64-07/F) Avail: CFSTI CSCL 11/6

Results are presented of isothermal holding experiments on Fe-50% Cu alloy with silica inclusions present. In addition to rapid dendrite coarsening, the inclusions are pushed by the growing dendrites; they collide, join and coalesce, and they coarsen by diffusion (Ostwald ripening). It is probable that similar effects occur during solidification of usual castings and ingots. A levitation melting, undercooling, and splat cooling device was modified to permit greater flexibility of operation and to incorporate ability to make chill plate castings (for study of mechanical properties as well as for structure). Dendrite arm spacing of commercial steel alloy castings made in this apparatus varies from about 50 microns for gas cooled specimens to less than 1 micron for splat cooled specimens. In work on Fe-Si-O alloy, no optically visible inclusions were found in splat cooled samples. Author (TAB)

**N69-13873#** Dow Chemical Co., Midland, Mich. Metallurgical Lab.
**DEVELOPMENT OF HIGH STRENGTH MAGNESIUM-BASE SHEET ALLOY Final Report**
Sidney L. Couling Aug. 1968 103 p refs
(Contract DAAA25-67-C-0160)
(AD-676580) Avail: CFSTI CSCL 11/6

A high strength magnesium sheet alloy has been developed, nominal composition of the alloy is 9 percent yttrium, 1 percent zinc, 0.5 percent zirconium, balance magnesium. Some of the shop and service characteristics of the alloy have been determined: tensile properties, creep properties, fatigue properties, corrosion resistance in salt water, corrosion resistance when protected by standard magnesium finishing system, weldability and strength of weldments. A high strength magnesium extrusion alloy with the nominal composition of 9.5 percent yttrium, 0.5 percent zirconium, balance magnesium has also been developed. Author (TAB)

**N69-13891#** Dayton Univ. Research Inst., Ohio.
**SOME PROPERTIES OF IRON, COPPER, AND SELECTED ALUMINUM ALLOYS INCLUDING TRUE STRESS-TRUE STRAIN AT REDUCED TEMPERATURES**
James M. Carson and John M. Hawn Sep. 1968 46 p refs
(Contract F33615-68-C-1138)
(AD-676706; AFML-TR-68-251; UDRI-TR-68-38) Avail: CFSTI CSCL 11/6

The metallurgical and mechanical properties of several face centered cubic materials (1100 Al, 7075-0 Al, 7075-T6 Al, OFHC Cu) and a body centered cubic material (Armco iron) were examined. Prior to undergoing tensile testing the materials were insured to have a nonoriented equiaxed grain structure and underwent chemical analysis and hardness tests. The materials were then tensile tested at 296K in the atmosphere, at 77K in a liquid nitrogen bath, and at 4K in liquid helium. A continuous record of the axial load and of two perpendicular specimen profile traces produced a measurement of specimen true stress-true strain. Engineering stress-strain, elongation, and reduction in area were also calculated. Author (TAB)

# 18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

**N69-12605** Connecticut Univ., Storrs.
**AN ANALYTICAL EVALUATION OF A HYPOTHETICAL THREE-PHASE MATERIAL**
Victor Arvydas Matonis (Ph.D. Thesis) 1967 173 p
Avail: Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 68-1377

The work studies analytically some aspects of the mechanical behavior of a hypothetical three-phase plastic material. The proposed material is a polyblend of spherical inclusions encapsulated with a layer of a low modulus elastomer and dispersed in the styrene-acrylonitrile matrix. Such material could serve as a replacement for the impact polystyrenes, styrene-acrylonitrile-butadiene, rubber modified polyvinyl-chloride and similar polyblends. Furthermore, such an approach could be used to enhance the ductility of the hard core composites. The elastic solutions for the generalized case were based on a singular multilayered inclusion in the otherwise infinite matrix under uniaxial tension. All material phases were considered as linearly elastic, isotropic and homogeneous. Both the two- and three-dimensional solutions are presented using two types of harmonic functions satisfying the equilibrium equations in terms of the displacements. Perfect adhesion at all interfaces was assumed. All solutions are exact and in the closed form. Dissert. Abstr.

**N69-12606** Cincinnati Univ., Ohio.
**STUDIES OF THE FLOW PROPERTIES UNDER HIGH SHEAR RATES OF SELECTED ORGANIC COMPOUNDS IN THE MOLECULAR WEIGHT RANGE OF LUBRICATING OILS**
Eran Raches (Ph.D. Thesis) 1967 208 p
Avail: Univ. Microfilms: HC $9.45/Microfilm $3.00 Order No. 68-2016

The flow characteristics of some selected, specially prepared, organic structures have been studied. The prepared compounds, basically 24-atom unit-chains with a varying functional group located at, or close to, the 7, and 18, positions were: 7,18-Tetracosanedione, 7,18-Tetracosanediol, 7,18-Diphenyl-7,18-tetracosanediol, 7,18-Dicyclopentyl-7,18-tetracosanediol, Dipentyldodecanedioate, Dipentyldodecanedioamide, 7,18-Dibromotetracosane, 1,12-Di-p-pentylphenyl-1,12-dodecanedione. Special care was taken to ensure a high degree of purity in these materials. The compounds have been studied, at temperatures above their melting points, in a high rate-of-shear, thin-film, concentric-cylinder viscometer.
Dissert. Abstr.

**N69-12937** Brown Univ., Providence, R. I.
**ELECTRON-SPIN RESONANCE STUDIES OF RADIATION INDUCED PARAMAGNETIC DEFECTS IN SEVERAL GLASS SYSTEMS**
Yong Moo Kim (Ph.D. Thesis) 1967 145 p
Avail: Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 68-1474

Gamma-irradiated glasses from three oxide systems were studied—alkali oxide–titanium oxide; niobium pentoxide–sodium oxide–silicon dioxide; lead oxide–boron oxide. All the glasses received a gamma-irradiation dose of $2 \times 10^7$ R, and were investigated at liquid nitrogen temperature. In alkali titanate glasses, the radiation-induced spectrum can be separated into two distinct resonance lines: one line is located at a g-value higher than that of the free electron, $g_e$, while the other is lower. In the $Nb_2O_5$–$Na_2O$–$SiO_2$ glasses, an irradiation-induced paramagnetic center gives rise to the so-called broad spectrum which is characterized by an axially symmetric g-factor and hyperfine interaction with the Nb(I = 9/2) nucleus. Gamma-irradiated lead borate glasses containing approximately 20 molar percent PbO exhibited a five-line spectrum similar to that observed for alkali borate glasses. Dissert. Abstr.

**N69-12968** Wisconsin Univ., Madison.
**EFFECTS OF MOLDING AND ANNEALING VARIABLES ON THE FATIGUE BEHAVIOR OF THERMOPLASTIC MATERIALS**
Oran Allan Pringle (Ph.D. Thesis) 1967 256 p
Avail: Univ. Microfilms: HC $11.70/Microfilm $3.30 Order No. 67-10646

Two amorphous materials and one crystalline material were investigated. Fatigue tests were made with a specially designed machine in which a large number of specimens were subjected to alternating fluid loading. The fluid loading permitted an aqueous environment, temperature control, and high testing speeds. Statistical data were obtained by using sample sizes of fifteen and twenty specimens. Small cantilever specimens were injection molded with and without stress concentration. Weibull distributions were fitted to the fatigue life data. All of the distributions had nonzero values of the minimum life parameter. S-N equations were fitted at constant probabilities of failure. Most of the S-N curves had nonzero values of the fatigue limit parameter. Dissert. Abstr.

**N69-12974** Brown Univ., Providence, R. I.
**SIMULTANEOUS STRESS RELAXATION AND CREEP OF POLYURETHANE IN THE NON-LINEAR RANGE**
James Sun-Yung Lai (Ph.D. Thesis) 1967 94 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-1477

In Part 1, a constitutive equation using multiple integral functional relationship for stress relaxation of non-linear viscoelastic material has been investigated for uniaxial stress. Relaxational functions involving strain rate terms up to the third order have been determined from several constant strain relaxation experiments. Part 2 presents a method of prediction of non-linear stress relaxation from a non-linear creep function under uniaxial stress. This creep function was determined from the multiple integral functional relationship, where the first three order terms were retained. Part 3 presents an experimental and theoretical investigation of the problem of mixed boundary values producing simultaneous relaxation and creep of a non-linear viscoelastic material under biaxial stresses. A method of prediction of simultaneous creep in torsion and relaxation in tension from constant stress creep tests under combined tension and torsion is presented. Dissert. Abstr.

**N69-13052#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ON THE VIBROCREEP OF POLYMERIC MATERIALS**
G. I. Barenblatt et al *In its* J. of Appl. Mech. and Tech. Phys. 5 Dec. 1967 p 1–13 refs (See N69-13051 03-34)
Avail: CFSTI

This paper presents experimental data and theoretical discussion on the phenomenon of vibrocreep in polymeric materials. The experimental procedure consisted of applying a vibratory stress to a specimen under a static stress and determining the resultant creep as a function of time. A schematic of the experimental setup is given, and the experimental results are presented graphically. The experimental results are compared with the theoretical expression. It was found that the application of an oscillating stress causes an increase in the creep velocity in polymeric materials. Author

**N69-13124*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**FRACTOGRAPHY OF POLYTETRAFLUOROETHYLENE (PTFE)**
B. H. Nerren 7 Nov. 1968 33 p
(NASA-TM-X-53728) Avail: CFSTI CSCL 11I

An attempt is made to apply the science of fractography of metallic materials to a polymeric material. The material used in this study was polytetrafluorethylene (PTFE). The approach to the study was to plan an investigation where controlled laboratory failures of PTFE would serve as standards for comparison to the unknown of a failure. These standards were planned for ambient and liquid nitrogen temperatures. The results demonstrated that the science of fractography is applicable to PTFE; further, that the failure environment of PTFE can be determined by using fractography. Author

**N69-13268*#** Monsanto Research Corp., Dayton, Ohio.
**IDENTIFICATION OF VOLATILE CONTAMINANTS OF SPACE CABIN MATERIALS Final Report, Jan. 1967–Feb. 1968**
J. V. Pustinger, Jr. and F. N. Hodgson Wright-Patterson AFB, Ohio AMRL Jul. 1968 178 p refs Prepared jointly with NASA
(Contract F33615-67-C-1357)
(NASA-CR-97918; AD-675177; AMRL-TR-68-27) Avail: CFSTI CSCL 22B

Fifty-three candidate materials for space cabin construction were tested to establish volatile gas-off and oxidation products. The preliminary screening by measuring weight loss was to determine those materials which exhibit weight losses between 0.001% and 1.0%, exclusive of water. Materials falling within this range were studied further in storage tests to determine the nature of the individual components evolved from the candidate material. Those materials falling outside this range were conditionally excluded from further tests. Weight loss data, thermogravimetric curves, gas chromatograms of volatile contaminants, and the nature and quantities of individual components evolved from the candidate materials are reported. Author (TAB)

**N69-13343#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**EXPERIMENTAL DETERMINATION OF THE THERMAL CONDUCTIVITY OF REFRACTORY HIGH-ALUMINA CONCRETE IN THE 200–1500 DEG C RANGE [EKSPERIMENTAL'NOYE OPREDELENIYE TEPLOPROVODNOSTI ZHAROUPORNOGO VYSOKOGLINOZEMISTOGO BETONA V INTERVALE TEMPERATUR 200–1500 DEO C]**
V. Ya. Chekhovskoy et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 312–316 refs (See N69-13314 03-03)
(SM-74/232) Avail: CFSTI

Refractory concrete based on high-alumina cement is widely used for lining and electrical insulation in arc and electric furnaces, and also in other thermal units operating at high temperatures.

Obviously such a material is promising for MHD uses especially in view of the fact that rather intricate parts can be made from concrete. Thus a study of thermophysical properties of high-alumina cement as a function of temperature is of interest. Thermal conductivity of refractory concrete in the 200–1500°C range is reported. Author

**N69-13366#** Explosives Research and Development Establishment, Waltham Abbey (England).
**COMPARATIVE STRESS RELAXATION TESTS FOR TWO GRADES OF POLYTETRAFLUOROETHYLENE**
B. L. Hammant and J. Roberts Jul. 1968 11 p refs
(AD-676943; ERDE-8/M/68) Avail: CFSTI CSCL 11/9

The mechanical relaxation stiffness of two grades of polytetrafluoroethylene (PTFE) are compared using the ERDE stress relaxation test. The materials are an unfilled PTFE and a filled PTFE. For short loading times the filled PTFE is found to be the stiffer material, but in the long term the unfilled PTFE has a better performance. Author (TAB)

**N69-13375#** Royal Aircraft Establishment, Farnborough (England).
**A PRELIMINARY NOTE ON THE CHEMICAL RESISTANCE OF SOME CARBON FIBER-EPOXY RESIN COMPOSITES**
N. C. W. Judd Apr. 1968 23 p refs
(RAE-TR-68085) Avail: CFSTI

The changes in flexural strength of some epoxy resin unidirectional R.A.E. carbon fiber composites resulting after immersion in boiling water have been measured. The weight, dimensional and Barcol hardness changes of the composites resulting from immersion in acid, alkaline and organic reagents were also investigated. The preliminary results indicate that carbon fiber composites have advantages when used in environments hostile towards glass. Of the composites examined an epoxy carbon fiber composite cured with a boron trifluoride catalyst offered the best all-round chemical resistance. Author (ESRO)

**N69-13435#** Edinburgh Univ. (Scotland). Dept. of Electrical Engineering.
**ELECTRONIC CONDUCTION PROCESSES IN GLASS**
A. E. Owen London Min. of Technol. Feb. 1968 19 p refs
Sponsored by Min. of Technol.
(D-MAT-152) Avail: CFSTI

This report on electronic conduction processes in glasses concerns: (1) electrical studies of arsenide sulphide glasses; (2) electrical studies of germanium-selenium systems; (3) electrical studies of transition-metal oxide glasses; (4) electron-spin-resonance and optical studies of transition-metal oxide glasses; (5) Hall and drift mobility measurements in semiconducting glasses. Future programs relating to structural and homogeneity studies on these materials are discussed. ESRO

**N69-13461#** Vermont Univ., Burlington.
**THE FRACTURE ENERGY OF COMPOSITE MATERIALS Final Report, 1 Sep. 1967–31 Aug. 1968**
John O. Outwater and Michael C. Murphy Sep. 1968 31 p refs
(Contract DAAA21-67-C-0041)
(AD-676863) Avail: CFSTI CSCL 11/4

A study of the sources of the fracture energy and hence the brittleness of laminates shows that one of the parameters governing the usefulness of a filament as a reinforcement for a matrix is the debonding energy in shear between the filament and the matrix. A novel method of measuring this value is described. Using this technique, values are determined for freshly drawn Pyrex rods with many different surface treatments embedded in anhydride cured epoxy resin. The effects of environment are shown and it is noted that all debonding energies tend to be substantially the same value after long exposure. Author (TAB)

**N69-13468#** Massachusetts Univ., Amherst. Polymer Research Inst.
**THE VARIATION OF CRYSTALS IN CRYSTALLINE POLYMERS**
William Chu and Richard S. Stein Sep. 1968 15 p refs
(Contract Nonr-3357(01))
(AD-676692; ONR-TR-110) Avail: CFSTI CSCL 7/4

Previous theories for the scattering from crystalline polymers having random orientation correlations were extended to the case of non-randomness where correlated regions deviate from spherical shape. Application is made of the previously suggested technique of measurement of scattered intensity as a function of polarization direction in order to evaluate non-randomness. This technique is applied to a series of low (LD), medium (MD) and high density (HD) polyethylene films crystallized at a series of temperatures. Author (TAB)

**N69-13469#** Massachusetts Univ., Amherst. Polymer Research Inst.
**THE SCATTERING OF LIGHT FROM DEFORMED REGIONS SURROUNDING VOIDS AND INCLUSIONS IN HIGH POLYMERS**
Richard S. Stein Mar. 1968 22 p refs
(Contract Nonr 3357(01))
(AD-676694; ONR-TR-89) Avail: CFSTI CSCL 7/4

The H(V) clover-leaf type scattering pattern sometimes found for amorphous polymers can arise from the birefringent region caused by the strain surrounding a void or an inclusion in a polymer. The form of such a pattern may be theoretically explained by extension of a theory due to Goldstein. Author (TAB)

**N69-13474#** Massachusetts Univ., Amherst. Polymer Research Inst.
**X-RAY AND OPTICAL STUDIES OF THE EFFECT OF ORIENTATION OF THE ALPHA MECHANICAL LOSS MECHANISM OF POLYETHYLENE**
Richard S. Stein, Akira Tanaka, Eng-Pi Chang, and I. Kimura (Toyobo Co., Shiga, Japan) Aug. 1968 14 p refs
(Contract Nonr-3357(01))
(AD-676691; ONR-TR-111) Avail: CFSTI CSCL 11/9

The alpha mechanical loss of low density polyethylene has been previously studied by the dynamic x-ray diffraction technique and has been shown to result, in part, from the rotation of crystals about their b-axes. This presumably is due to the twisting motion of lamellae in the equatorial regions of spherulites. The intensity of this loss increases up to about 10% strain and subsequently decreases. The dynamic birefringence changes primarily arise from this phenomena and also exhibit a similar change in intensity with strain. While both dynamic x-ray diffraction and dynamic birefringence measurements are possible for low-density polyethylene, experimental limitations permit only the birefringence measurements for high density polyethylene. The increase in loss intensity with strain at low strains is attributed to the increase in lamellae mobility associated with the splaying apart of lamellae within the deformed spherulite. The subsequent decrease in mobility with further strain is associated with the decrease in crystal mobility associated with the extension of tie chains between crystallites in the strained polymer. Author (TAB)

**N69-13620*#** Brown Engineering Co., Inc., Huntsville, Ala. Advanced Systems and Technologies Group.
**ULTRAVIOLET DEGRADATION OF THIN FILMS OF ZINC OXIDE**
J. D. Hayes, R. R. Mitchell, and H. J. Watson Aug. 1968 40 p refs
(Contract NAS8-20166)
(NASA-CR-98164; AST-379) Avail: CFSTI CSCL 11C

The effect of ultraviolet radiation on the Hall mobility in zinc oxide has been studied for thin films of zinc oxide. The increase in mobility with electron concentration as varied by photoexcitation has been found to follow the course to be expected with the neutralization of a charged film surface. For a given carrier concentration, the mobility increases with film thickness. Conductivity measurements have shown that the temperature dependence of the conductivity in the temperature interval between 77°K and 300°K is strongly dependent on the initial conductivity of the sample. Optical transmission measurements in the region of the fundamental absorption edge have shown no change in transmission for samples exposed to moderate doses of ultraviolet radiation. Author

**N69-13648#** College of Aeronautics, Cranfield (England). Dept. of Materials.

**A STUDY OF THE STRESS DISTRIBUTIONS NECESSARY TO MAINTAIN RUBBER IN A STATE OF TORSION**

M. M. Hall Jun. 1968 68 p refs

(COA-NOTE-MAT-17) Avail: CFSTI

Quantitative measurements have been made of the time dependent normal stress distributions and torques which are necessary to maintain a state of torsion in: (i) a solid right circular cylinder of rubber, (ii) rubber contained between a cone and touching flat plate. The measurements on the solid rubber cylinder, under quasi-elastic conditions cannot be described by the kinetic theory of elasticity. There are considerable experimental difficulties involved in measurements on the cone and plate system but these results also suggest an inadequacy in the ability of the kinetic theory to describe finite deformations in rubbers. Author

**N69-13658#** Massachusetts Univ., Amherst. Polymer Research Inst.

**THE SCATTERING OF LIGHT FROM ASSEMBLIES OF ORIENTED RODS**

Marion B. Rhodes and Richard S. Stein Aug. 1968 46 p refs

(Contract Nonr-3357(01))

(AD-676696; ONR-TR-48) Avail: CFSTI CSCL 7/4

The scattering patterns are calculated from anisotropic rods having an arbitrary orientation of the principal polarizability axis with respect to the rod axis. The effect of a distribution of orientation of the rods is explored, leading to a change in scattering patterns produced by orienting the rods upon stretching the sample. Scattering patterns are affected by the relationship between the refractive indices of the rods and that of the surroundings. The influence of the optic axis orientation angle changing upon orienting the rods is explored. Theoretical patterns are compared with experimental ones obtained upon stretching polytetrafluorethylene (PTFE) films. Author (TAB)

**N69-13839#** Naval Research Lab., Washington, D. C.

**WETTABILITY AND MAIR INFRARED SPECTROSCOPY OF SOLVENT-CAST THIN FILMS OF POLYAMIDES AND POLYPEPTIDES Interim Report**

R. E. Baier and W. A. Zisman 16 Sep. 1968 28 p refs

(AD-676888; NRL-6755) Avail: CFSTI CSCL 7/4

Polyamides, such as the nylons, polypeptides, and proteins, may have variable surface properties as the result of the masking or exposure of surface hydrogen-bonding sites which may greatly influence their behavior. An earlier investigation with the polyamide nylon 66, showing a wettability difference by hydrogen-bonding and nonhydrogen-bonding liquids, was confirmed and extended in the present work with nylon 11, nylon 6, and nylon 2 (polyglycine). This difference in wettability behavior seems diagnostic, when present in conjunction with a high critical-surface-tension range, for the presence of accessible amides in a polymer surface. Investigations of the more complex polypeptides, polymethylglutamate, and polybenzylglutamate by contact-angle determination and multiple attenuated internal reflection (MAIR) infrared spectroscopy on solvent-cast thin polymer films showed that the hydrogen-bonding capacity of the common polyamide backbone could be masked by either bulky side-chain substituents or by certain configuration changes of the polymer chain. Elimination of the hydrogen-bonding ability at nylon surfaces might also accompany polymer fractionation in different solvents, slight configuration changes, or a combination of both. Author (TAB)

**N69-13872*#** Babcock and Wilson Co., Alliance, Ohio. Research and Development Div.

**DEVELOPMENT OF A HIGH STRENGTH, HIGH MODULUS CERAMIC FIBER Final Summary Report, 29 Jun. 1967–29 Sep. 1968**

R. N. Fetterolf 29 Sep. 1968 91 p refs

(Contract NAS8-21186)

(NASA-CR-98156; B&W-5144) Avail: CFSTI CSCL 11E

The goal of this program is the development of a high-strength, high-modulus, continuous ceramic fiber by salt decomposition process. The desired properties of such a fiber are a length greater than 1,000 feet, diameter of less than 125 microns, tensile strength greater than 250,000 psi, modulus of elasticity greater than 30,000,000 psi, and corrosion resistance equal to or better than that of E-glass fiber. An overall process for the production of a ceramic oxide continuous filament from fiberizable salt solution has been defined. The process consists of five unit operations: (1) solution preparation; (2) fiber formation by extrusion-attenuation; (3) fiber collection; (4) fiber drying; and (5) fiber calcination to oxide form. Fiber quality yardsticks have been defined as fired or unfired fiber diameter, uniformity of diameter with respect to length, and tensile strength and modulus of elasticity. Fiber tensile strength has been found to increase as fiber diameter decreases. Study and eventual control of variables found to affect fiber quality have been almost completed. Author

# 19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

**N69-12625** Michigan Univ., Ann Arbor.

**ON LATTICES OF INVARIANT SUBSPACES**

Peter Michael Rosenthal (Ph.D. Thesis) 1967 79 p

Avail: Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 67-17837

Two general questions concerning lattices of invariant subspaces are investigated in this paper. The first question is: which lattices are attainable? There are very few known attainable lattices; the main purpose of Chapter I is to provide further examples of such lattices. It is shown that the direct product of countably many attainable lattices is attainable. The second question considered is: what properties of operators follow from properties of their lattices of invariant subspaces? In Chapter II some results in answer to this question are discussed. Some examples are given of lattices that are not attainable by compact operators, and of lattices not attainable by polynomially compact operators. A major portion of Chapter II is devoted to the study of completely reducible operators. In Chapter III other unsolved problems concerning lattices of invariant subspaces are discussed. Dissert. Abstr.

**N69-12651** Michigan Univ., Ann Arbor.

**ENTROPY AND THE COMPLEXITY OF GRAPHS**

Abbe Mowshowitz 1967 128 p

Avail: Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-17819

This study is addressed to the problem of measuring the relative complexity of graphs. The principal aim of the study is to demonstrate the usefulness of the entropy function as a measure of the relative complexity of graphs. This objective is pursued in two ways. First, a detailed, systematic treatment of an entropy measure defined with respect to the automorphism group of a graph is presented. In so doing, some tools for studying entropy measures in general are developed; and a basis for a complete classification of graphs in terms of this one particular measure is established. Second, a measure defined in terms of a class of chromatic decompositions is examined, largely for the sake of comparison with the first measure. The comparison is intended to highlight those peculiar structural characteristics of a graph which are reflected in the behavior of each of the respective measures. Dissert. Abstr.

N69-12685# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ONE METHOD OF APPROXIMATION OF COMPLEX FUNCTIONS**
K. S. Khomyakov *In its* Computer Eng., No. 5 24 Nov. 1967 p 249-253 refs (See N69-12660 03-08)
Avail: CFSTI

A formulation is given of the complex problems met in conjunction with computer control of shock tools, i.e., drill rigs, perforators. An approximating function is offered which is useful in many situations. Author

N69-12742 Arizona Univ., Tucson.
**OPTIMAL TRAJECTORIES WITH STATE VARIABLE AND CONTROL VARIABLE INEQUALITY CONSTRAINTS**
Frederick Henry Lutze, Jr. (Ph.D. Thesis) 1967 128 p
Avail: Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 68-787

The calculus of variations technique is applied to the problem of Lagrange formulated in the modern notation using state and control variables. The necessary conditions for optimal control are developed for problems which include state and control variable constraints in addition to the usual dynamical equations of constraint. In this development, the variations of the state variables are related to the variations of the control variables through the dynamical equations of constraint and, where applicable, through the state and control variable equations of constraint. The solution to the optimal control problem with state and control variable inequality constraints is shown to consist of a trajectory which includes several sub-arcs, those where the inequality is satisfied, and those where the inequality becomes an equality. Dissert. Abstr.

N69-12814 Oregon State Univ., Corvallis.
**AN ITERATIVE PROCEDURE FOR THE SOLUTION OF NONLINEAR EQUATIONS IN A BANACH SPACE**
Sergei Kalvin Aalto (Ph.D. Thesis) 1968 51 p
Avail: Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 68-1147

In 1964, Zarantonello published a constructive method for the solution of certain nonlinear problems in a Hilbert space. The method is extended in various directions, including a generalization to a Banach space setting. A revealing geometric interpretation of the method yields guidelines for the analysis. Dissert. Abstr.

N69-12830# Princeton Univ., N. J. Plasma Physics Lab.
**EXACT SOLUTIONS OF A CLASS OF NONLINEAR WAVE EQUATIONS**
E. M. Krushkal 1968 5 p refs Transl. into ENGLISH from Russian Preprint 197
(Contract AT(30-1)-1238)
(MATT-Trans-65) Avail: CFSTI

A simple method of solution of equations of the type $F_1(y_t)y_{tt} = F_2(y_x)y_{xx}$ often occurring in nonlinear mechanics is shown. Author (NSA)

N69-12850 Louisiana State Univ., Baton Rouge. Agricultural and Mechanical Coll.
**PERIODIC AND ALMOST PERIODIC VECTORS**
Alan Carl Pierce (Ph.D. Thesis) 1967 40 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-17341

In this paper the classical concept of periodic and almost periodic functions is generalized by considering an arbitrary strongly continuous semi-group of operators acting on a complex Banach space. Let X be a complex Banach space and $\{T(t);\ t \geq 0\}$ a strongly continuous semi-group of bounded linear operators on X with infinitesimal generator A. A vector $x \in X$ is said to be periodic of period $\lambda > 0$ (with respect to $\{T(t);\ t \geq 0\}$) if $T(\lambda)x = x$. Let $P(\lambda)$ be the set of vectors periodic of period $\lambda$ and let P be the linear span of $\bigcup_{\lambda>0} P(\lambda)$. The first chapter contains basic results about the space $P(\lambda)$. Dissert. Abstr.

N69-12854 California Univ., Berkeley.
**WAVE OPERATORS AND SIMILARITY FOR SOME OPERATORS IN BANACH SPACES**
Charles Sue-Chin Lin (Ph.D. Thesis) 1967 73 p
Avail: Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 68-104

Let X and Y be complex reflexive separable Banach spaces. Let $C_0(X,Y)$ be the class of all closed densely defined operators from X to Y. $C_0(X)$ stands for $C_0(X,X)$. Let $T \in C_0(X)$ with its resolvent set $\rho(T) \supset \Omega_+$ and let $\tilde{T} \in C_0(X)$ with $\rho(\tilde{T}) \supset \Omega_-$ such that $T \subset \tilde{T}$, where $\Omega_\pm = \{z | \pm z > 0\}$. Let V be an operator which can be factored formally as the product BA of two operators $A \in C_0(X,Y)$ and $B \in C_0(Y,X)$. Conditions are given under which the perturbed operators $T(\kappa)$ and $\tilde{T}(\kappa)$, formally given by $T + \kappa BA$ and $\tilde{T} + \kappa BA$ respectively, are similar to T and $\tilde{T}$ respectively. These similarities are established by explicitly constructing a non-singular operator $W(\kappa)$ which actually implements the similarities. T. Kato considered the perturbation problem in which the X, Y above are separable Hilbert spaces and the resolvent set of the unperturbed operator T contains both the upper and the lower half planes $\Omega_\pm$. Our results are generalizations of his from Hilbert spaces to more general Banach spaces. Dissert. Abstr.

N69-12865 Washington Univ., St. Louis.
**ON A CHARACTERIZATION OF REGULARLY BRANCHED THREE-SHEETED COVERING RIEMANN SURFACES AND THE EXISTENCE OF ANALYTIC MAPPINGS AMONG THEM**
Boo-Sang Lee (Ph.D. Thesis) 1967 84 p
Avail: Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 67-17190

Let R be a Riemann surface and M(R) the family of non-constant meromorphic functions on R. For $f \in M(R)$ we define P(f) to be the number of values on the Riemann sphere which are not taken by f on R and denote $\inf_{f \in M(R)} P(f)$ by P(R). We call P(R) the Picard's constant of R. Then $P(R) \geq 2$ for every open Riemann surface R. We confine our attention to those Riemann surfaces that are three-sheeted covering surface defined by $y^3 = g(z)$ where g(z) is a single-valued transcendental regular function in D, where D is either the domain $|z|\ |z| < \infty|$ or $|z|\ 0 < |z| < \infty|$ and g(z) has an infinite number of simple or double zeros in D. In this case g(z) is said to be admissible for $S_3(D)$ where $S_3(D)$ denotes the class of all such surfaces R, and we simply say that R is defined by $y^3 = g(z)$. If H(z) is single-valued and regular in D, then we denote by $H_0$ the constant term in Laurent expansion of H(z) at origin. Dissert. Abstr.

**N69-12929** California Inst. of Tech., Pasadena.
**ON THE CESARI FIXED POINT METHOD IN A BANACH SPACE**
Stephen Andrew Williams (Ph.D. Thesis) 1967 27 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-14356

L. Cesari introduced a method which extends certain earlier existence theorems for perturbation problems to strictly nonlinear problems. Various authors have now applied this method to linear ordinary and partial differential equations. The basic idea of the method is to use the contraction principle to reduce an infinite-dimensional fixed point problem to a finite-dimensional problem which may be attacked using the methods of fixed point indexes. A formulation of the Cesari fixed point method is given. Dissert. Abstr.

**N69-12931** New Mexico State Univ., University Park.
**FK SPACES AND VARIATION MATRICES**
John Joseph Sember (Ph.D. Thesis) 1967 94 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-269

An FK space is a vector space of complex-valued sequences equipped with a locally convex Fréchet topology for which the coordinate linear functionals are continuous. This thesis is devoted to an investigation of infinite matrix mappings between certain types of FK spaces, with special emphasis placed on variation matrices, that is, those infinite matrices that preserve sequences of bounded variation, where a sequence of complex numbers is of bounded variation if the series converges. Results obtained are often compared with corresponding results from the theory of conservative matrices. The collection of triangular variation matrices is regarded as a Banach algebra T, and several results are obtained concerning the radical and the set of left topological zero divisors of this algebra. Dissert. Abstr.

**N69-12986*#** Brown Univ., Providence, R. I. Center for Dynamical Systems
**ON THE STABILITY OF RANDOMLY SAMPLED SYSTEMS**
H. J. Kushner and L. Tobias (NASA. Electron. Res. Lab.) 1968 27 p refs
(Grants NGL-40-002-015; AF-AFOSR-693-67; NSF GK-2788)
(NASA-CR-97866) Avail: CFSTI CSCL 12A

Randomly sampled linear systems with linear or nonlinear feedback loops are studied by a stochastic Liapunov function method. The input, in this paper, is assumed zero. Improved criteria for stability, with probability one, on $s^{th}$ moment $s > 1$, or in mean square are given, when the sequence of holding times are independent. The method is relatively straightforward to apply, especially in comparison with the direct method, and allows the study with nonlinear feedback, or non-stationary holding times. A randomly sampled Lurè problem is studied. Numerical results, describing some interesting phenomena, such as jitter stabilized systems are presented. Author

**N69-13075** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electron.
**COMPUTATION RESEARCH**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 231-235 (See N69-13060 03-34)
(Contract DA-28-043-AMC-02536(E))
Avail: CFSTI

Progress in computation research methods using the IBM 360/65 computer are reviewed. A set of numerical integration programs in Fortran IV was developed which utilized Gaussian Quadrature formulas to evaluate integrals which could not be evaluated using more conventional methods, such as the Trapezoidal Rule or Simpson's Rule. A Fortran subroutine was written to compute the Weber function and Neumann function. An assembly language program is available which reads and writes binary tapes. B.P.

**N69-13121** Michigan State Univ., East Lansing.
**A METHOD TO IMPROVE THE ANALOG COMPUTER SOLUTION OF LINEAR SYSTEMS**
William Thomas Marquitz (Ph.D. Thesis) 1967 101 p
Avail: Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 68-4179

In the analog computer solution of the system of first order linear differential equations with constant coefficients, certain errors and stability problems result. A new approach for reducing the errors, called the correction procedure, is followed. From the given models of the active computing elements, it is determined what changes must be made in the potentiometers of the computer set up for the given state equations such that a vector, which is the output of n active elements, is of the same order as that of X(t) and has the solution to $d/dt\ X(t) = -A\ X(t)$, S(0). The correction procedure is easy to apply and only the potentiometer settings are affected. Also the number of active computing elements is not increased. Dissert. Abstr.

**N69-13180#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE EXPANSION OF THREE-VALUED LOGIC FUNCTIONS**
B. A. Kaklyugin *In its* Theory of Struct. and Signal Formation 20 Oct. 1968 p 7-17 refs (See N69-13178 03-10)
Avail: CFSTI

A general method is proposed for expanding three-valued logic functions for various base operators. The possibility is discussed of realizing three-valued logic functions by three-component elements, and the algorithm for three-valued logic algebra is given, as well as a general formula for the expansion of a two-variable function. A general expansion formula is also presented. The results show that expansion formulas can be set up for all cases. It is also indicated that no one has attempted to solve this problem, and that three-component elements are one of the main difficulties. Only a few types have been developed and these are comparatively complex. A three-component element made up of tunnel diodes appears to be best suited for solving this problem. Author

**N69-13222*#** Rice Univ., Houston, Tex. Dept. of Mechanical and Aerospace Engineering and Materials Science.
**USE OF THE METHOD OF PARTICULAR SOLUTIONS IN NONLINEAR, TWO-POINT BOUNDARY-VALUE PROBLEMS. PART 2: CONTROLLED SYSTEMS**
John C. Heideman 1968 21 p refs
(Grant NGR-44-006-089)
(NASA-CR-98509; AAR-51) Avail: CFSTI CSCL 12A

The nonlinear, two point boundary value problem relevant to a particular controlled system is solved. First, quasilinearization techniques are used to replace the nonlinear system with one that is linear. Then, the method of particular solutions is used to solve the linear problem, and the procedure is employed iteratively. Three variations of this procedure are presented, one converging to a family of solutions and two converging to a unique solution. Author

**N69-13278*#** Brown Univ., Providence, R. I.
**INFINITE DIMENSIONAL MULTIPOINT METHODS AND THE SOLUTION OF TWO POINT BOUNDARY VALUE PROBLEMS**
W. E. Bosarge, Jr. and P. L. Falb Sep. 1968 43 p refs
(Grants NGR-40-002-015; NSF GK-2788)
(NASA-CR-97901; CDS-TR-68-6) Avail: CFSTI CSCL 12A

The problem of determining the roots of an equation of the form $F(x) = 0$ is considered where F maps the Banach space X into itself. Convergence theorems for the iterative solution of $F(x) = 0$ are proved for multipoint algorithms of the form $x_{n+1} = x_n - \phi_\alpha(x_n)$, $\alpha \geq 1$. The theorems are applied to the solution of two point boundary value problems of the form $dy/dt = f(y, t)$, $g(y(0)) + h(y(1)) = c$. A set $\{A(t), B, C\}$ of matrices is called boundary compatible if the linear two point boundary value problem $dy/dt = A(t)y + k(t)$, $By(0) + Cy(1) = d$ has a unique solution for all $k(t)$ and $d$. Then, under certain conditions, there are boundary compatible sets such that the problem $dy/dt = f(y, t)$, $g(y(0)) + h(y(1))$ has an equivalent integral representation. Such an equation is viewed as an operator equation of the form $F(x) = (I-T)(x) = 0$, and convergence conditions for the iterative solution are deduced from the general theorems. Explicit interpretations of the convergence results are given in terms of f, g, h and some illustrative numerical examples are presented. Author

**N69-13368*#** National Aeronautics and Space Administration, Washington, D. C.

**COMPUTERIZED ARRHENIUS RELIABILITY EXTRAPOLATION TECHNIQUES**

Charles R. Toye (Elec. Res. Center) Dec. 1968 16 p refs

(NASA-TN-D-4902) Avail: CFSTI CSCL 12A

Computerized mathematical techniques and algorithms useful in obtaining extrapolated component failure rates derived from the Arrhenius equation are presented. The mathematics of the Arrhenius equation is reviewed. A computer program for the calculation of an important constant in the equation is given, and a computerized extrapolation procedure is illustrated. Author

**N69-13369*#** Stanford Univ., Calif.

**WEAK CONVERGENCE OF PROBABILITY MEASURES ON PRODUCT SPACES WITH APPLICATIONS TO SUMS OF RANDOM VECTORS**

Donald L. Iglehart 4 Mar. 1968 28 p refs Sponsored in part by NASA Prepared in cooperation with Cornell Univ.

(Contracts Nonr-225(53); Nonr-401(55))

(NASA-CR-97917; AD-668557; TR-109) Avail: CFSTI CSCL 12A

Let C superscript K be the product of K copies of C(0,1), the space of continuous functions on (0,1) with the uniform metric, and D superscript K the product of K copies of D(0,1), the space of right continuous functions on (0,1) having left limits with the Skorohod metric. Necessary and sufficient conditions are obtained for the weak convergence of a sequence of probability measures (pn) on C superscript K (or D superscript K) to a probability measure P. These results are then applied to obtain functional central limit theorems for sums of random vectors. The random vectors considered are either independent and identically distributed or stationary phi-mixing. Extensions to the case of sums of a random number of random variables are also treated. Author (TAB)

**N69-13383#** Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.

**SOLUTION OF A LINEAR PARTIAL DIFFERENTIAL EQUATION WITH CONSTANT COEFFICIENTS [RISOLUZIONE DI UNA EQUATIONE DIFFERENZIALE LINEARE ALLE DERIVATE PARZIALI A COEFFICIENTI COSTANTI]**

D. Giucci 8 Jul. 1968 26 p refs In ITALIAN; ENGLISH summary

(ISS-68/22) Avail: CFSTI

This report presents some methods which are used in the study of partial differential equations. These methods, widely described in literature, are utilized, as an example, for the solution of a particularly simple type of linear partial differential equation with constant coefficients. Author

**N69-13408#** Southern Methodist Univ., Dallas, Tex. Information and Control Sciences Center.

**APPROXIMATE SOLUTION ALGORITHMS FOR NONLINEAR FILTER PROBLEMS**

Andrew P. Sage 1968 5 p refs

(Contract F44620-68-C-0023)

(AD-676802; AFOSR-68-2026) Avail: CFSTI CSCL 12/1

This paper presents a summary and evaluation of several approximation procedures which may be used to obtain maximum a-posterior density estimates, least integral square error and minimum covariance of error sequential state and parameter estimators in nonlinear systems. A simple example which illustrates the similarities and differences of the computational algorithms for the various methods is presented. Author (TAB)

**N69-13438#** Case Western Reserve Univ., Cleveland, Ohio. Systems Research Center.

**SOME RESULTS IN A THEORY OF PROBLEM SOLVING, PART 2 Interim Report**

R. B. Banerji Nov. 1967 175 p refs

(Grants AF-AFOSR-125-67; NSF GK-1386)

(AD-676293; SRC-68-10-Pt-2; AFOSR-68-2083) Avail: CFSTI 12/2

The report considers the effect that specific language descriptions have on the efficiency of pattern recognition and problem solving methods. The efficiency of a language for the description of a given set is viewed in terms of the size, in some sense, of the shortest expression that denotes the set. Central to the discussion are questions of how the description of a concept should be stored to use the smallest amount of memory, and how the description should be stored and processed so that, given an object and a concept, an efficient determination can be made on containment of the object in the concept. The languages are essentially non-numeric, enabling pre-processing to be described in the same format as that used for pattern description. Algorithms for learning and generalization are presented that use two of the languages. The property of succinctness is considered for the algorithms, and the effect of lack of succinctness on the statistical degree of confidence in the learned description is indicated. Analogies are made to descriptions in terms of discriminant functions and maximum likelihood ratios. Author (TAB)

**N69-13448#** Aeronautical Chart and Information Center, St. Louis, Mo. Lingustic Section.

**ON THE TRANSITION FROM RECTANGULAR SPACE COORDINATES TO GEODETIC COORDINATES [O PEREKHODE OT PROSTRANSTVENNYKH PRYAMOUGOL NYKH KOORDINAT K GEODEZICHESKIM]**

A. V. Butkevich Sep. 1968 9 p refs Transl. into ENGLISH from Geodez. i Kartograf. (Moscow), no. 6, 1967 p 20-22

(AD-676495; ACIC-TC-1428) Avail: CFSTI CSCL 8/5

It is sometimes necessary to make a transition from the geodetic coordinates to the rectangular space coordinates and vice versa. Direct transition can be made simply by formulas, but inverse transition in all existing methods is made either by the method of successive approximations, or by the method of differential corrections. The translation is a mathematical solution to this problem. Author (TAB)

**N69-13459#** European Atomic Energy Community, Ispra (Italy). Reactor Physics Dept.

**INTERACTING KNOTS IN GEOMETRODYNAMICS**

K.-H. Muller Brussels Aug. 1968 24 p refs

(EUR-4048.e) Avail: CFSTI

Physics can be interpreted as the totality of all physically perceptible aspects of the fluctuating space-age continuum. This geometrization leads, among other facts, to discrete stable and

normalizable solutions called space-age knots. Such knots transport perturbation and interact with another. Kinematics and dynamics of systems of a sufficient high knot density are governed by a transport equation. Author

**N69-13467#** Hebrew Univ., Jerusalem (Israel). Dept. of Mathematics.
**CHARACTERIZATION OF THE KERNELS OF CONVEX GAMES**
M. Maschler, B. Peleg, and L. S. Shapley (RAND Corp.) Jul. 1968 38 p refs
(Contract F61052-67-C-0094; N0014-66-C-0070)
(AD-676552; RM-36) Avail: CFSTI CSCL 12/2

It is proven that the kernel (for the grand coalition) of a convex game consists of a unique point and its location is characterized geometrically. Author (TAB)

**N69-13527#** Virginia Polytechnic Inst., Blacksburg.
**THE DISTRIBUTION OF Z GAMMA AND THE COMPLEX CONJUGATE OF Z WHEN THE DISTRIBUTION OF THE COMPLEX VARIABLE Z IS A MEMBER OF A PARTICULAR FAMILY OF DISTRIBUTIONS**
Archie D. Brock and Richard G. Krutchkoff 1 Jul. 1968 243 p refs
(Contract DA-ARO(D)-31-124-G410)
(AD-676859; TR-68-3) Avail: CFSTI CSCL 12/1

An eight parameter family of densities is introduced which contains several of the well-known density functions as particular cases. We reserve the functions f and g to denote this family, or one of its particular cases, in the r-theta plane and x-y plane, respectively. We will show that if the distribution of Z is determined by the eight parameter family, then the distributions of Z superscript gamma and $Z^{*}$ (the complex conjugate of Z) are also determined by the eight parameter family. We then obtain estimators and some properties of these estimators for some particular cases of the family. Author (TAB)

**N69-13544#** Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.
**QUATERNARY MATRIX ALGEBRA AND RIEMANN'S CURVE IN TEMPORAL SPACE [QUATERNIONS ESPINORES E CURVATURA RIEMANNIANA NO ESPACO TEMPO]**
C. Marcio do Amaral 6 Jun. 1968 60 p refs In PORTUGUESE
*Its* Notas de Fisica, vol. 14, no. 1
Avail: CFSTI

The present study clarifies and establishes the role of quaternions in relativity theory by examining the connection between spinors and the quaternion formalism of relativity. Quaternions are used to formulate a theory of two-component natural mode spinors independent of any theory of representation. It is shown that the connection between Bergmann formalism and tetrade formalism of relativity is identifiable by Bergmann's matrix formulation when an adequate quaternion base is used. Author

**N69-13554#** Washington Univ., Seattle. Dept. of Mathematics.
**TWO RENORMING CONSTRUCTIONS RELATED TO A QUESTION OF ANSELONE**
Victor Klee Oct. 1968 18 p refs
(Contract N00014-67-A-0103)
(AD-676513; TR-10) Avail: CFSTI CSCL 12/1

The report is devoted to a certain property of normed linear spaces, found by Anselone to be useful in studying the total boundedness of sets of linear operators. Anselone suggested the (desirable) possibility that all normed linear spaces should have the property. Here this is shown to be unfortunately not the case, for (a) every infinite-dimensional separable Banach space can be renormed so as to lack the property and (b) Hilbert space can be renormed so as to be Gateaux-smooth at each point of its unit sphere S, Frechet-smooth at all but two points of S, and yet to lack the property of Anselone. Author (TAB)

**N69-13560#** New York Univ., N. Y. Courant Inst. of Mathematical Sciences.
**ON THE ESTIMATION OF LOCATION PARAMETERS IN THE MULTIVARIATE ONE SAMPLE AND TWO SAMPLE PROBLEMS**
Madan Lal Puri and Pranab Kumar Sen (North Carolina Univ.) Feb. 1968 28 p refs Prepared in cooperation with North Carolina Univ.
(Contract N00014-67-A-0467; Grant PHS-GM-12868)
(AD-676728; IMM-369) Avail: CFSTI CSCL 12/1

The report describes the problem of estimating the vectors of location parameters in the multivariate one sample and two sample problems. These estimators are obtained through the use of the multivariate rank order statistics such as the Wilcoxon or the normal scores statistic. The distribution of these estimators is shown to be symmetric with respect to the parameters being estimated. These estimators are translation invariant, robust and asymptotically normal. Their asymptotic relative efficiencies with respect to the estimators based on the vector of means and medians are discussed by applying the criterion of Wilks generalized variance. In particular, it is shown that the estimators based on the multivariate normal scores statistics are asymptotically as efficient as the ones based on the method of least squares when the parent distributions are normal. Author (TAB)

**N69-13565*#** Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
**FORMAL SOLUTIONS FOR A CLASS OF STOCHASTIC PURSUIT-EVASION GAMES Interim Technical Report**
W. W. Willman Nov. 1968 123 p refs
(Grant NGR-22-007-068; Contract N00014-67-A-0298-0006)
(NASA-CR-97912; TR-575) Avail: CFSTI CSCL 12A

A class of differential pursuit-evasion games is examined in which the dynamics are linear and perturbed by additive white Gaussian noise, the performance index is quadratic, and both players receive measurements perturbed independently by additive white Gaussian noise. A direct application of the saddle point condition is used formally to characterize linear minimax solutions in terms of a system of implicit integro-differential equations, which appears to be more complicated than the ordinary kind of two point boundary value problem. It is also shown that games of this type possess a "certainty-coincidence" property, meaning that their behavior coincides with that of corresponding deterministic games in the event that all noise values are zero. This property is used to decompose the minimax strategies into sums of a certainty-equivalent term and error terms. Author

**N69-13672#** Western Reserve Univ., Cleveland, Ohio. Mathematics Dept.
**SOME PROPERTIES OF ASYMPTOTICALLY STABLE SETS IN DYNAMICAL SYSTEMS**
Paul R. Fallone, Jr. (Ph.D. Thesis) Sep. 1967 74 p refs
Avail: Univ. Microfilms: HC $4.60

The structure of asymptotically stable sets in dynamical systems is explored, and results are obtained relating to the topological properties of these sets and their regions of attraction and to the nature of the dynamical system in and near these sets. Author

**N69-13692#** Ballistic Research Labs., Aberdeen Proving Ground, Md.
**NUMERICAL SOLUTIONS OF POLYNOMIAL EQUATIONS**
Tadeusz Leser and Henry Wisniewski Aug. 1968 37 p refs
(AD-676108; BRL-TN-1699) Avail: CFSTI CSCL 9/2

The report describes the FORTRAN Subroutine POLYR and a related complete program BRL-RSSR for finding all roots (real and complex) of a real polynomial equation P(x) = Summation from i = o to i = N of ((A sub i)(x to the power (N-i))) =0. The method which is used combines the root squaring and the subresultant (extracting quadratic factors) procedures for calculating all roots, even multiple roots, of real polynomials. Reconstruction of the coefficients serves as a means of checking. Author (TAB)

**N69-13706#** New York Univ., N. Y. Courant Inst. of Mathematical Sciences.
**NONPARAMETRIC CONFIDENCE REGIONS FOR SOME MULTIVARIATE LOCATION PROBLEMS**
Madan Lal Puri and Pranab Kumar Sen Jun. 1968 16 p refs
(Contract N00014-67-A-0467; Grant PHS-GM-12868)
(AD-676727; IMM-370) Avail: CFSTI CSCL 12/1

Nonparametric methods of constructing confidence regions for the location vectors in the multivariate one-sample and two-sample problems are provided. These methods are based on a class of rank order statistics. Specifically, nonparametric confidence regions based on Bonferroni inequality, the maximum modulus, and Scheffes method are studied. The results obtained are nonparametric generalizations of some of the results of Dunn and Sidak. Certain optimality properties of the proposed methods are also established. Author (TAB)

**N69-13716#** George Washington Univ., Washington, D. C.
**SOME PROPERTIES OF STIRLING NUMBER OF THE SECOND KIND**
Rosedith Sitgreaves 2 Oct. 1968 18 p refs
(Contract N00014-67-A-0214; Proj. Logistics Research)
(AD-676912; T-213) Avail: CFSTI CSCL 15/5

Stirling numbers of the second kind occur in the sampling distributions of statistics involved in a model of demand prediction. This paper describes some properties of these numbers which will be useful in later discussions of distribution theory. Author (TAB)

**N69-13731#** Washington Univ., Seattle. Computer Science Group.
**A FORMAL DEDUCTIVE PROBLEM-SOLVING SYSTEM Interim Technical Report**
J. R. Quinlan and E. B. Hunt 9 Feb. 1968 48 p refs Submitted for publication
(Grants AF-AFOSR-1311-67; NSF 87-1438R)
(AD-676017; TR-68-1-01) Avail: CFSTI CSCL 9/2

A formal description of a generalized theorem proving computer program is given. The program has been written in Fortran IV, but this description is concerned with logical flow and definitions of the algorithm, rather than programming details. Examples of performance of the program are given, using several fields of mathematics for illustrative purposes. Author (TAB)

**N69-13768#** Northwestern Technological Inst., Evanston, Ill.
**ON SOME NONSTANDARD SEMI-INFINITE PROGRAMMING PROBLEMS**
Abraham Charnes, William W. Cooper, and Kenneth O. Kortanek Mar. 1968 25 p refs Prepared in cooperation with Carnegie-Mellon Univ. and Cornell Univ.
(Contracts Nonr-1228(10); DA-31-124-ARO(D)-322; Nonr-760(24); Grant NSF GK-1581)
(AD-676514; SRM-201) Avail: CFSTI CSCL 12/2

The main purpose of this paper is to develop and prove a duality theorem for a special nonstandard semi-infinite programming problem over Hilberts Field. Attention centers on semi-infinite programming problem real coefficients but whose complete regularizations involve powers of the Nonarchimedean element. A duality result is given which states conditions under which the infinum of the primal problem equals the maximum of the dual problem, possibly involving finite powers of the relative infinites. Author (TAB)

**N69-13788#** Northwestern Technological Inst., Evanston, Ill.
**ON DECOMPOSITIONS OF MATRIX SPACES WITH APPLICATIONS TO MATRIX EQUATIONS**
Adi Ben-Israel Jul 1968 12 p refs
(Contracts Nonr-1228(10); DA-31-124-ARO(D)-322; Grant NSF GP-7550)
(AD-676515; SRM-213) Avail: CFSTI CSCL 12/1

A theorem on the decomposition of C superscript mxn, the space of mxn complex matrices, into a direct sum of orthogonal complementary subspaces is proved here as a consequence of the corresponding theorem in C superscript mn, the mn dimensional complex vector space. Applications to matrix equations are given. Author (TAB)

**N69-13775#** Illinois Univ., Urbana. Antenna Lab.
**SOME ANALYTICAL METHODS FOR SOLVING A CLASS OF BOUNDARY VALUE PROBLEMS**
G. F. Van Blaricum, Jr. and R. Mittra Jun. 1968 106 p refs
(Contract AF 19(628)-3819)
(AD-676300; AL-68-3; AFCRL-68-0362; TR-16) Avail: CFSTI CSCL 20/14

A variety of boundary problems, related to basic Wiener-Hopf geometries but of more practical interest, has been solved by a modified residue-calculus technique (MRCT), by the generalized scattering matrix technique, or by a combination of the two methods. The MRCT solution is given in a form convenient for computation, not involving numerical integration or solution of large order matrix equations. In addition, the MRCT automatically guarantees satisfaction of the edge condition and includes built-in tests on the convergence of the solution. An additional group of modified Wiener-Hopf geometries in which modal expansions are possible are solved by a combination of the MRCT and the generalized scattering matrix procedure. The analytical methods described in this report are applicable to waveguide discontinuities, including steps, bifurcations, and diaphragms, in both rectangular and circular waveguides; to phased arrays of dielectric-filled waveguides with thick walls; to a variety of diffraction surfaces and gratings; and to many other modified Wiener-Hopf geometries. Author (TAB)

**N69-13811#** Northwestern Technological Inst., Evanston, Ill.
**ON $K_U$-SYMMETRIC AND $K_U$-p.d. MATRICES WITH APPLICATIONS TO HYPER-POWER METHODS OF GENERALIZED INVERSION**
Sanjo Zlobec and Adi Ben-Israel Jul. 1968 31 p refs
(Contracts Nonr-1228(10); DA-31-124-ARO(D)-322; Grant NSF GP-7550)
(AD-676516; SRM-214) Avail: CFSTI CSCL 12/1

The concepts of K-symmetric and K-p.d. operators, introduced by Wigner and Petryshyn are generalized in the matrix case and applied to the hyper-power iterative methods of generalized inversion studied by Petryshyn and Zlobec. Author (TAB)

**N69-13851#** RAND Corp., Santa Monica, Calif.
**ON THE COMPATIBILITY BETWEEN A GRAPH AND A SIMPLE ORDER**
Fred S. Roberts Sep. 1968 35 p refs Submitted for publication
(Contract F44620-67-C-0045)
(AD-676640; RM-5778-PR) Avail: CFSTI CSCL 12/1

A formal graph-theoretic approach to measurement problems, such as those occurring in psychology, sociology, and economics is given. The relation of indifference is represented by adjacency in a graph. Since indifference is symmetric, the graph is unoriented (preference relations are asymmetric and result in oriented graphs). The psychological notion of threshold, or just noticeable difference

(ind), suggests a problem in which numbers are assigned to points so that indifference exists relative to the two objects represented (i.e., so that the two points are adjacent) if and only if the numbers are close. The present study generalizes the problem to that of ordering the points of a graph (rather than numbering them) so that two nonadjacent points cannot be included between two adjacent points. This notion of compatible ordering turns out to be more general than numbering because it permits theorems to be proved for graphs with an arbitrarily large (infinite) number of points. Author (TAB)

**N69-13855#** Aerospace Corp., El Segundo, Calif. Technical Operations.
**NUMERICAL SOLUTION OF NONLINEAR TWO-POINT BOUNDARY PROBLEMS BY FINITE DIFFERENCES USING NEWTON'S METHOD**
James F. Holt May 1968 62 p refs
(Contract F04695-67-C-0158)
(AD-676968; TR-0158(3307-02)-10; SAMSO-TR-68-385) Avail: CFSTI CSCL 12/1

One method of solving nonlinear two-point boundary problems is to replace the nonlinear differential equations with implicit finite difference equations, linearize the nonlinear simultaneous algebraic equations, and solve them by an iterative process using Newtons well-known rule. This report describes this method in complete detail, gives a set of finite-difference equations for a general class of nonlinear two-point boundary problems, discusses the storage and solution of the band matrix, and suggests techniques for overcoming the difficulties of obtaining good initial guesses for the iterative procedure. Two examples are given to clarify the use of the method. The first example has multiple solutions, and both examples have boundary conditions specified at infinity. Author (TAB)

**N69-13863#** North Carolina Univ., Chapel Hill. Dept. of Statistics.
**ON THE DISTRIBUTION OF THE LAST OCCURRENCE TIME IN AN INTERVAL FOR A REGENERATIVE PHENOMENON**
C. C. Heyde Oct. 1968 19 p. refs *Its* Mimeo Ser. No. 597
(Contract Nonr-855(09))
(AD-676880) Avail: CFSTI CSCL 12/1

Let (E(t), t >0) be a family of regenerative events, as originally introduced by Kingman, and let Z(t, omega) = 1 if omega is a member of E(t) and be zero otherwise. Define T sub t = suplu : o < or = u < or = t; Z(u, omega = 1). This paper obtains various theorems about T sub t and studies its limiting behavior as t approaches infinity. Author (TAB)

# 20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

**N69-12866** St. Louis Univ., Mo.
**THE ROLE OF DIABATIC HEATING IN THE NUMERICAL PREDICTION OF LONG WAVES**
Chi Fung Chow (Ph.D. Thesis) 1967 70 p
Avail: Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 68-1259

A two level model incorporating heating was developed to investigate the behavior of the atmospheric long waves. The technique of introducing heating permitted a free upper boundary with respect to vertical motion; thereby, permitting the vertically integrated divergence to be other than zero. The model permitted the near steady state long waves which characterize observed long wave behavior. The validity of the approach was demonstrated by two independent numerical investigations. 1) Realistic heating values obtained from independent investigations were substituted into the equations under assumed steady state conditions. 2) The observed behavior of the harmonic components covering a specific five day period was computed and substituted in the appropriate equations of the model. The hopeful significance of this investigation is that it will lead to some applicable dynamic principles pertinent to extended period weather prediction. Dissert. Abstr.

**N69-12825#** Joint Publications Research Service, Washington, D. C.
**METEOROLOGY**
*In its* Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 192 20 Nov. 1968 p 7-57 refs (See N69-12823 03-34)
Avail: SOD/CFSTI

Abstracts of scientific and technical articles are presented on the following: (1) development and description of meteorological instruments, including electronics for rocket probes, microthermistors for high-altitude measurements, and laser photography through clouds; (2) techniques and methodology in arctic weather forecasting, velocity correlation in isotropic turbulent flow, artificial modification of glaciers, cloud physics and hydrodynamic cloud models, computation of structural wind loads, automatic isoline mapping, processing of meteorological data, radar wind profiling and other wind measurements, and short-range forecasting; (3) phenomenological studies on atmospheric circulation over water, mountains, plane slopes, and complex terrain, temperature regimes, turbulences in stratified atmospheres and over flat terrain, atmospheric stratification, vertical currents, molecular nitrogen in the upper atmosphere, and models of radiation fog; and (4) synoptic studies dealing with hail formation, wind measurement, vertical currents, and foehn in various parts of the U.S.S.R. K.W.

**N69-12934*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**ATMOSPHERIC LIMITS ON THE OBSERVATIONAL CAPABILITIES OF AEROSPACECRAFT**
John C. Evvard Washington Dec. 1968 23 p refs
(NASA-TN-D-4940) Avail: CFSTI CSCL 04B

Atmospheric turbulence decreases the ground observational capability of an aerospacecraft. Most of the effect arises from transient distortions of the light path near the surface (up to 15 or 20 km) where the air density is high. Hence, the viewing accuracy of a satellite observer looking at the ground is generally much higher than for a ground observer viewing a satellite. Estimates of the atmospheric resolving power error for both the ground and the aerospacecraft observer have been made. The estimated uncertainty of viewing a point on the ground directly beneath an aerospacecraft need be no larger than 12 centimeters. Expressions are derived for the altitude and angular dependency of the uncertainty. Author

**N69-13400#** Institut Royal Météorologique de Belgique, Brussels. Inst. d'Hygiène et d'Epidémiologie.
**AIR POLLUTION: SMOKE AND $SO_2$ [POLLUTION ATMOSPHERIQUE: FUMEE ET $SO_2$] Monthly Bulletin, Apr. 1968**
1968 13 p In FRENCH and FLEMISH
Avail: CFSTI

Daily measurements made in April 1968 in the regions of Brabant, Liège, Hainant, and Anvers of the air pollution are given in tabular form. Graphs of daily variations of smoke and $SO_2$ in the agglomerations of Liège, Charleroi, and Anvers are also presented. ESRO

N69-13401# Institut Royal Météorologique de Belgique, Brussels. Inst. d'Hygiène et d'Epidémiologie.
**AIR POLLUTION: SMOKE AND $SO_2$ [POLLUTION ATMOSPHERIQUE: FUMEE ET $SO_2$] Monthly Bulletin, May 1968**
1968 14 p In FRENCH and DUTCH
Avail: CFSTI

Daily measurements made in May 1968 of the air pollution are given in tabular form. Graphs of daily variations of smoke and $SO_2$ in the agglomerations of Liège, Charleroi, and Anvers are also presented. ESRO

N69-13432# Air Weather Service, Scott AFB, Ill.
**THE USE OF TRAJECTORIES IN TERMINAL FORECASTING**
Aug. 1968 57 p refs
(AD-676295; AWS-TR-210) Avail: CFSTI CSCL 4/2

The Winter Trajectory Test Program was conducted as part of the AWS Forecaster Assistance Program. The objective of this test was to determine if three-dimensional trajectories derived from the output of the AFGWC Six-Level Forecast Model are useful in the preparation of terminal forecasts. Hq AWS personnel used trajectory data to evaluate forecasts prepared at detachments in the central and eastern United States and to modify some of these forecasts. These trajectory data improved the four-month verification of the terminal forecasts by 3.1 percent. Tests were conducted in 1 Wea Wg and 2 Wea Wg and results from these overseas units are discussed. Forecast procedures and the application of objective rules developed during the winter evaluation are described in several case studies. Author (TAB)

N69-13440*# Texas A&M Univ., College Station. Oceanography Dept.
**ON THE QUESTION OF LOW-LEVEL CLOUD RESPONSE TO THE TEMPERATURE FIELD OF THE SEA SURFACE**
James E. Arnold Sep. 1968 94 p refs Supported in part by NASA
(Contract Nonr-2119(04))
(NASA-CR-97919; AD-676231) Avail: CFSTI CSCL 04B

Weekly averages of wind and air-sea temperature differences from ship reports averaged over four-degree quadrilaterals, revealed that increased wind velocities required larger air-sea temperature differences to maintain a maximum cloud amount at low cloud levels for spring and summer cases. During winter the situation was reversed with increased wind velocities requiring less air-sea temperatures to maintain above average cloud amounts. This was also reflected in the individual ship reports. A similar examination of cloud amounts at low levels and the air-sea temperature difference gave some indication that at least a 1C change in air-sea temperature difference was required to produce a change of 1/8 coverage in the low cloud field. Simple correlation coefficients between low clouds and air-sea temperature differences, wind, and dewpoint depression were small, with the correlation between clouds and wind being the highest with a value of 0.57. A seasonal trend of total cloud amount over the Gulf of Mexico from February to August existed in both ship and satellite data. Maximum cloudiness was observed in winter and summer, and a cloud minimum in April and May. The minimum cloud period reflected the presence of the subtropical high and the associated atmospheric subsidence rather than significantly decreased instability in the surface layers. Author (TAB)

N69-13448# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**LARGE PARTICLES IN CLOUDS [KRUPNYE CHASTITSY V OBLAKAKH]**
A. M. Borovikov, I. P. Mazin, and A. N. Nevzorov Nov. 1967 13 p refs Transl. into ENGLISH from Tr. Vses. Nauchn. Meteorol. Soveshch. (USSR), v. 5, 1963 p 73-82
(AD-676556; FTD-MT-24-277-67) Avail: CFSTI CSCL 4/2

The article presents measurement data on the concentration and size spectra of particles carried out by means of a special instrument which makes it possible to scan clouds at a rate of several cubic meters per minute. At the same time, the instrument records the threshold sizes of droplets of 150, 250, 450 and 800 microns (at high amplification) and 410, 730, 1430, and 2400 microns (at low amplification). Author (TAB)

N69-13508# Institut Royal Météorologique de Belgique, Brussels. Inst. d'Hygiène et d'Epidemiologie.
**AIR POLLUTION: SMOKE AND $SO_2$ [POLLUTION ATMOSPHERIQUE: FUMEE ET $SO_2$] Monthly Bulletin, Mar. 1968**
1968 13 p In FRENCH and FLEMISH

Daily measurements made in March 1968 in the regions of Brabant, Liège, Hainant, and Anvers of the air pollution are given in tabular form. Graphs of daily variations of smoke and $SO_2$ in the agglomerations of Liège, Charleroi, and Anvers are also presented. ESRO

N69-13530# National Weather Records Center, Asheville, N. C.
**METEOROLOGICAL ROCKET NETWORK FIRINGS, DATA REPORT, VOLUME 5, NUMBER 2**
Feb. 1968 203 p
Avail: SOD $3.00

Wind and temperature measurements from all available meteorological sounding rocket firings are presented, along with computed values for pressure, density, and speed of sound. Local radiosonde observation nearest the time of firing are included. Author

N69-13629*# Lockheed-California Co., Burbank.
**A STUDY OF JIMSPHERE WIND PROFILES AS RELATED TO SPACE VEHICLE DESIGN AND OPERATIONS**
S. I. Adelfang, E. V. Ashburn, and A. Court Washington NASA Nov. 1968 116 p refs
(Contract NASS-20747)
(NASA-CR-1204; LR-21588) Avail: CFSTI CSCL 04B

During the period December 1964 through April 1967, Jimsphere wind sensors were used to obtain 1194 profiles in the altitude range 1 km to 20 km over Cape Kennedy. This report consists of an analysis of the winds and wind shears derived from the Jimsphere data. The zonal and meridional components of the wind were found to have a distribution that is significantly closer to a normal distribution that the distribution of the components determined for the winds measured by conventional radiosonde methods. Extreme ($\geq$ 95%) Jimsphere wind speeds at 7 km through 15 km are not independent of the extreme wind speeds at 12 km altitude. Mean shears at 8, 12, and 16 km are a function of a power of the shear layer thickness, $\Delta z$ for $\Delta z \leq 1$ km. The power is 1 for mean zonal and scalar shears, not clearly defined for mean meridional shears, and 2/3 for mean vector shears. The standard deviation and the 95% scalar, vector, zonal, and meridional shears are also a function of the altitude interval $\Delta z$ to the 2/3 power. Given that the shear is extreme at 12 km altitude the simultaneous occurrence of non-overlapping extreme vector and zonal shears measured over altitude layers of 50 to 1000 meters, is a low probability event. Definitions of steady state wind and gusts are discussed in terms of filtering the wind data for the relevant frequency ranges and in terms of space vehicle characteristics. Author

N69-13661# Texas Univ., Austin. Atmospheric Science Group.
**VARIANCE SPECTRUM ANALYSIS**

Amos Eddy, Claude E. Duchon, and James A. Almazan Mar. 1968 372 p refs
(Contract DA-29-040-AMC-1602(R); Grant NSF FA-367X)
(AD-676876; REPT-8) Avail: CFSTI CSCL 4/2

Variance Spectrum Analysis stands as one of the tools of the trade used by the geophysicist in his search for certain species of order which he suspects might be buried somewhere in the noisy recesses of his data sample. For certain jobs, it is a beautiful precision tool; for other jobs, it is useless. The report presents one method of attack which has been used with some success in the examination of the principles underlying the technique of variance spectrum analysis. We feel that we have taken a step in the right direction by translating into terms which the average applied meteorologist can follow - the details of an analysis technique which has heretofore rested in the hands of a meager few meteorologists while being common knowledge to the electrical engineering profession. The approach is our own, and stands as it does simply because we have found it quite useful to view the entire technique as a special case of regression analysis. Author (TAB)

**N69-13728#** Joint Publications Research Service, Washington, D. C.
**METEOROLOGY**
*In its* Soviet-Bloc Res. in Geophys., Astronomy, and Space 29 Nov. 1968 p 7-11 (See N69-13728 03-34)
Avail: CFSTI

Meteorological scientific and news articles are reviewed. The theory of short wave radiation affecting the earth's climatic changes was discussed. The circulation processes for the northern hemisphere were analyzed and applied to long range forecasts. The characteristics of the spring natural synoptic season in the Eastern Caucasus and the return of cold weather in Azerbaydzhan are described. An effort was made to find an effective criterion which would make it possible to judge the character of the effect of the underlying surface on the vertical distribution of an aerosol. An experimental study was made of the brightness of multiple scattered light in simulated media and in artificial fogs and mists. B.P.

**N69-13740#** Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
**DAILY AND MONTHLY NORTHERN HEMISPHERE. 10 MILLIBAR-SYNOPTIC WEATHER MAPS OF THE YEAR 1967. PART 3: JULY-SEPTEMBER**
Dietrich Just, Barbara Kriester, Karin Labitzke, Renate Lenschow, Karin Petzoldt et al Sep. 1967 109 p
(Contract DAJA37-67-C-0786)
(AD-676833; QTSR-3) Avail: CFSTI CSCL 4/2

These reports are published quarterly and present 10 mb maps, day by day, throughout 1961-present. Height and temperature data are plotted on each chart and appropriate contours are drawn. A discussion of the stratospheric circulation for each quarter is concluded. Each volume also contains mean monthly maps and charts of changes in the means from month to month, for the appropriate months. Author (TAB)

**N69-13760#** Freie Univ., Berlin (West Germany).
**DAILY AND MONTHLY NORTHERN HEMISPHERE 31-MILLIBAR-SYNOPTIC WEATHER MAPS OF THE YEAR 1967, PART 3 Quarterly Technical Status Report, Jul.-Sep. 1967**
Dietrich Just, Barbara Kriester, Karin Labitzke, Renate Lenschow, and Karin Petzoldt 1968 110 p *Its* Meteorol Paper vol. 61, no. 3
(Contract DAJA37-67-C-0786)
(AD-676839; QTSR-3) Avail: CFSTI CSCL 4/2

The reports are published quarterly and present 30 mb maps, day by day, throughout 1961-present. Height and temperature data are plotted on each chart and appropriate contours are drawn. A discussion of the stratospheric circulation for each quarter is included. Each volume also contains mean monthly maps and charts of changes in the means from month to month, for the appropriate months. Author (TAB)

**N69-13773#** Woods Hole Oceanographic Institution, Mass.
**WIND MEASUREMENTS FROM BUOYS: A SAMPLING SCHEME**
Robert C. Millard, Jr. Oct. 1968 39 p refs
(Contract N00014-66-C-0241)
(AD-676767; WHOI-REF-68-68) Avail: CFSTI CSCL 4/2

Long records of wind are desired to test the influence of lower frequency atmospheric stress variations on the ocean. A spectrum of wind variations covering periods from 20 days to two seconds has been formed using measurements collected with several sampling rates. Since the purpose of the measurements is to define low frequency variations, sampling schemes to minimize the influence of high frequency variations within the data capacity of the instrument are desired. Several sampling schemes for describing low frequency variations were tested using an oversampled time series. An optimum sampling procedure, in the sense that it minimizes the amount of contamination variability folded into the frequency range of interest for a limited number of data cycles, was found. This sampling technique adequately represents frequencies of .2 c.p.h. Author (TAB)

**N69-13826#** Colorado State Univ., Fort Collins.
**STRUCTURE OF STABLY STRATIFIED TURBULENT BOUNDARY LAYER**
Satya Pal Singh Arya Sep. 1968 177 p refs
(Contract DA-AMC-28-043-65-G20)
(AD-676868; CER68-69SPSA10) Avail: CFSTI CSCL 4/1

The structure of a stably stratified thick boundary layer developed in a meteorological wind tunnel is investigated experimentally. Measurements of mean velocity, mean temperature, turbulent intensities, shear stress, heat fluxes and turbulent spectra made at a station 78 ft from the leading edge are reported. Turbulent quantities were measured by using different hot-wire probes; the measurement technique which is a modification of the procedure suggested by Kovasznay (1953) is described. The results show that stability greatly reduces the turbulence in the boundary layer. The structure of the wall layer is discussed in the light of Monin and Obukhovs (1954) similarity theory and Ellisons (1957) theory. The results are also compared with previous measurements in the laboratory and in the surface layer of the atmosphere in stable conditions. It is shown that mean flow and turbulent characteristics of the wind tunnel boundary layer are well described by the similarity theory, and that this theory provides a good basis for the wind tunnel modeling of similar characteristics of the atmospheric surface layer. Measured spectra of lateral and vertical velocity fluctuations are shown to agree with Kolmogorovs (1941) similarity theory irrespective of the stability. The results are compared with Heisenbergs (1948) theory for the equilibrium spectra of temperature fluctuations are shown to have similar form in agreement with Corrsins (1951) theory. No buoyancy subrange could be identified in any of the spectra. Author (TAB)

## 21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

No abstracts in this issue.

# 22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

**N69-12688#** Atomics International, Canoga Park, Calif.
**SELF-DIFFUSION OF URANIUM AND CARBON IN URANIUM MONOCARBIDE**
G. G. Bentle and G. Ervin, Jr. 30 Aug. 1968 21 p refs
(Contract AT(04-3)-701)
(AI-AEC-12726) Avail: CFSTI

Diffusion coefficients of carbon and uranium in uranium carbide 4.4 to 4.9 wt % C were measured by tracer and sectioning techniques on specimens annealed at 1100° to 2000°C. Carbon diffusion was faster than uranium diffusion by two or three orders of magnitude. There was a small dependence on composition; higher carbon caused some increase in carbon diffusion and a decrease in uranium diffusion. The specimens varied in grain size but no significant differences were found between the coarse-grained and fine-grained specimens. Breaks occurred in the Arrhenius curves at about 1500°C; the lower activation energies below 1500°C were attributed to short-circuiting by grain boundary or sub-grain boundary transport in the low temperature region. Five studies of self-diffusion in UC are reviewed and compared with th present results. Author (NSA)

**N69-12690#** Los Alamos Scientific Lab., N. Mex.
**INTEGRAL GAMMA AND NEUTRON MEASUREMENTS ON THE PHOEBUS 1B REACTOR**
A. John Ahlquist, R. W. Henderson, E. F. Montoya, W. H. Schweitzer, and F. C. V. Worman 6 Sep. 1968 31 p refs
(Contract W-7405-ENG-36)
(LA-3746) Avail: CFSTI

Data on the neutron fluence and neutron and gamma doses measured during the four experimental plans involving criticality of the Phoebus 1B reactor are presented. The reactor was surrounded by a 360° open-well shield, which changed the leakage radiation pattern measured on previous unshielded reactor tests. The new radiation pattern is discussed and compared to earlier reactors. Also included are depth dose measurements in the shield and miscellaneous gamma measurements near the reactor. Author (NSA)

**N69-12730#** Argonne National Lab., Ill.
**[FAST REACTOR FUELS AT THE KARLSRUHE FACILITY IN GERMANY] Monthly Report**
Robert E. Macherey Aug. 1968 7 p
(TID-24680; MR-48) Avail: CFSTI

Irradiation programs are described for various composition $PuO_2$–$UO_2$ fuels. Cladding performances are also described. Fuel cladding properties of Mo- and V-alloys are presented. NSA

**N69-12790** Rensselaer Polytechnic Inst., Troy, N. Y.
**THE APPLICATION OF VARIATIONAL METHODS TO THE PULSED NEUTRON PROBLEM**
James Douglas Jenkins (Ph.D. Thesis) 1967 178 p
Avail: Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 68-828

The behavior of pulsed neutron systems whose decay is not always dominated by a fundamental mode is investigated. Such systems include large ranges of fast multiplying assemblies and of thermal moderating assemblies. A complete numerical eigenfunction–eingenvalue analysis is carried out for several fast multiplying assemblies. Exact solutions are obtained for the GODIVA and SUAK systems and for natural uranium assemblies. These results are compared with experiment and are used to provide understanding of the physical processes governing the system response and to provide a basis of comparison for variational methods which are developed. Dissert. Abstr.

**N69-12812#** Idaho Nuclear Corp., Idaho Falls.
**BURNUP DETERMINATION OF NUCLEAR FUELS Quarter Project Report, 1 Jan.–31 Mar., 1968**
Frederick L. Lisman, ed., William J. Maeck, ed., and James E. Rein, ed. Aug. 1968 28 p refs
(Contract AT(10-1)-1230)
(IN-1215) Avail: CFSTI

In a continuing program to develop methods for the accurate determination of the burnup of nuclear fuels, the main emphasis was the measurement of the thermal fission yields of many stable and long-lived fission products of Pu-241. The main measurement technique was isotope dilution mass spectrometry. The determined thermal fission fields relative to $^{148}Nd$ and the calculated absolute fission yields are given. Author (NSA)

**N69-12815#** Institute of Nuclear Research, Warsaw (Poland).
**DETERMINATION OF EPITHERMAL CELL PARAMETERS IN WWR-SM CRITICAL ASSEMBLY CORES**
Edward T. Jozefowicz 1968 16 p
(INR-919) Avail: CFSTI

Methods of epithermal cell parameters measurements in normal elementary cell of the WWR-SM type, multitube enriched fuel, water moderator, are described. The results of irradiations of fuel pellets in the investigated lattice are normalized to the thermal spectrum using Dy foils and irradiations in the thermal column. Integral counting of fission products and the chromatographic separation of $^{239}Np$ is applied. Author (NSA)

**N69-12822#** Canadian General Electric Co., Ltd., Peterborough (Ontario). Civilian Atomic Power Dept.
**DESIGN CURVES FOR SPENT FUEL SHIELDING**
K. R. Shultz and P. A. Khor 15 May 1967 137 p
(DF-67-CAP-24) Avail: CFSTI

Through slab shields of several common, single materials the $\gamma$ dose rates were calculated for isotopic point and line sources of spent fuel. Results are shown as curves of: dose rate vs thickness, dose rate vs decay time, and integrated dose vs exposure time. For each material representative curves following reactor operation of unit power for 100 hr, 1000 hr and infinite hours are presented. Examples of application are given. Author (NSA)

**N69-12857#** Oak Ridge National Lab., Tenn. Technical Information Div.
**THE SIGNAL-NOISE RATIO OF A TIME-DEPENDENT FILTER FOR IMPROVEMENT OF THE ENERGY RESOLUTION IN NUCLEAR RADIATION SPECTROSCOPY WITH SEMICONDUCTOR DETECTORS**
K. Weise [1968] 7 p refs Transl. into ENGLISH from Nucl. Instr. and Methods (Amsterdam), no. 61, [1968] p 241–244
(ORNL-TR-1971) Avail: CFSTI

The signal-to-noise ratio of a time-dependent filter proposed by Schuster for improving the energy resolution in nuclear spectroscopy with semiconductor detectors is calculated and found to be only 3.7% below the value of the optimum filter and better than the signal-to-noise ratios of other filters, especially 31% greater than that of the RC-integration-RC-differentiation-filter commonly used. Author (NSA)

**N69-12861** State Univ. of Iowa, Iowa City.
**AN ANALOG SIMULATION OF THE CHEZEM–HELMICK MODEL OF A TWO-CORE REACTOR**
Alberto Manuel Campos (Ph.D. Thesis) 1967 102 p
Avail: Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 68-2804

An analog computer circuit is developed in this work for the simulation of the neutronic behavior of the two cores of a coupled-core reactor according to the model of Chezem and Helmick. The Laplace transform forms of the equations are used and these are solved as differential equations. The analog simulator consists of four amplifier-integrators, four amplifier-summers and 9 potentiometers, and permits simultaneous reading and recording of the neutron generation rates in both the pulsed core and the passive core. This analog simulator circuit has been checked with the four cases experimentally studied by the proponents of the model and was found accurate to within the accepted limits for analog computer calculations for runs not exceeding about 30 seconds of machine time. Dissert. Abstr.

**N69-12868** Stanford Research Inst., Menlo Park, Calif.
**LIDAR OBSERVATIONS OF THE EXHAUST PLUME OF A NUCLEAR-POWERED ROCKET ENGINE Final Report**
John Oblanas Aug. 1968 39 p refs
(Contracts AT(04-3)-115; W-7405-ENG-48)
(UCRL-13358) Avail: CFSTI

Lidar (laser radar) observations of the particulate matter within the exhaust plume of a nuclear powered rocket engine are described. The observations were made by a ruby lidar 5.5 km from the NRX-A6 engine operating at full power in a static test mount on December 15, 1967, at the Nuclear Rocket Development Station, Nevada. The observational data were analyzed to obtain volume backscatter coefficient of the exhaust plume as a function of time, values of volume backscatter coefficient of the plume and the attenuation through the plume, and relative density variations of the particulate matter within the plume. These analyses are presented and discussed. It is concluded that the experiment has demonstrated the feasibility of lidar for the remote, real-time monitoring of the particulate matter within a nuclear rocket exhaust plume. Author (NSA)

**N69-12876** Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.
**IRRADIATION TESTING OF CERAMIC FUELS Final Summary Report**
W. P. Chernock, G. Zuromsky, S. Christopher, and J. J. Koziol Mar. 1968 307 p refs
(Contract AT(30-1)-2936)
(CEND-2936-335) Avail: CFSTI

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1. PHASE RELATIONSHIPS 46 p (See N69-12877 03-22)
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**N69-12877** Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.
**PHASE RELATIONSHIPS**
*In its* Irradiation Testing of Ceram. Fuels Mar. 1968 46 p (See N69-12876 03-22)
Avail: CFSTI

Methods of preparation, sintering procedures, and heat treatment techniques used in preparing specimens for a study of phase relationships in the $UO_2$–$ZrO_2$–CaO and the $UO_2$–$CeO_2$ systems of reactor fuels are reported. A single phase, face centered cubic region was developed in the $ZrO_2$ rich portion of the $UO_2$–$ZrO_2$–CaO system at 1700°C or higher and a single phase, face centered cubic solid solution was obtained by firing $UO_2$–$CeO_2$ compositions of up to 21 mole % $UO_2$ in air. NSA

**N69-12878** Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.
**EX-REACTOR PROPERTY EVALUATIONS**
*In its* Irradiation Testing of Ceram. Fuels Mar. 1968 37 p (See N69-12876 03-22)
Avail: CFSTI

Data on the thermal conductivity, melting point, thermal expansion, and corrosion behavior of $CeO_2$-base $UO_2$ and $UO_2$–$ZrO_2$-base fuel compositions are reported. The $ZrO_2$ used in the compositions was stabilized with CaO. Equipment and techniques used in the experiments are described and illustrated and structural changes are shown by photomicrographs. NSA

**N69-12879** Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.
**FABRICATION OF IRRADIATION TEST SAMPLES**
*In its* Irradiation Testing of Ceram. Fuels Mar. 1968 22 p (See N69-12876 03-22)
Avail: CFSTI

Flow sheets are shown for the preparation of $ZrO_2$ base and $CeO_2$ base fully enriched $UO_2$ irradiation test samples, as are methods for cladding, assembly, and end plug welding. Results of X-ray examinations, metallographic and chemical analyses, and corrosion tests are discussed. NSA

**N69-12880** Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.
**IRRADIATION PROGRAM**
*In its* Irradiation Testing of Ceram. Fuels Mar. 1968 49 p (See N69-12876 03-22)
Avail: CFSTI

Data are reported on the performance of reactor fuels containing $UO_2$ in solid solution with CaO-stabilized zirconia and ceria at fission burnups of 40, 55, and 70% of the U-235 atoms at temperatures just below the melting points. Fuel parameters are tabulated, summaries of burnup data from nuclear mockup experiments are shown, and design of fuel capsules and components are illustrated. NSA

**N69-12881** Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.
**POST-IRRADIATION EXAMINATION**
*In its* Irradiation Testing of Ceram. Fuels Mar. 1968 104 p (See N69-12876 03-22)
Avail: CFSTI

A detailed report of post-irradiation examinations conducted on $CeO_2$ base and $ZrO_2$ base $UO_2$ fuel elements, including visual examination of irradiated capsules and specimens, burnup analysis, fission gas release, dimensional measurements and sectioning plans, metallography, autoradiography, and X-ray diffraction data, and results of corrosion tests. NSA

**N69-12882** Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.
**ANALYSES OF POST-IRRADIATION DATA**
*In its* Irradiation Testing of Ceram. Fuels Mar. 1968 21 p ref (See N69-12876 03-22)
Avail: CFSTI

A discussion and analysis of thermal conductivity measurements, fission gas release, grain growth, and dimensional changes in irradiated ceria base and zirconia base $UO_2$ systems as they affect performance of these fuels. NSA

**N69-12889** State Univ. of Iowa, Iowa City.
**SOLUTION OF SPACE-TIME KINETIC EQUATIONS FOR COUPLED-CORE NUCLEAR REACTORS**
Neal Edward Carter (Ph.D. Thesis) 1967 150 p
Avail: Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 68-2806

The modal analysis technique has been used in this study to solve the space-time kinetic equations for coupled-core nuclear reactors. In this formulation the neutron flux is expanded in a series of space dependent basis functions having time dependent expansion coefficients. The Green's Function Modes, obtained by solving the diffusion equations with sources fixed in various subregions of the reactor, were used as the space functions, and a variational principle was utilized to determine a set of time coefficients for the modes. The most significant advantage of the overall analytical technique is its versatility. The technique enables one to obtain the response of a reactor to perturbations of a step, ramp, or oscillatory nature. The space modes are determined as the solution to a set of differential equations with certain boundary conditions, and the solution involves no source iteration in that the only information required is the solution to the steady state problem. Dissert. Abstr.

**N69-12906#** Atomics International, Canoga Park, Calif.
**LARGE RADIOISOTOPE HEAT SOURCE CAPSULE (LRHSC) Quarterly Technical Status Report, 1 Apr.–30 Jun. 1968**
15 Aug. 1968 55 p refs
(Contract AT(29-2)-2338)
(AI-AEC-12713; QPR-4) Avail: CFSTI

Progress is reported on the development of a large radioisotope heat source capsule capable of operating in a space environment at a surface temperature of about 2000°F for five years or more. The objectives of the program are to design, fabricate, test, and evaluate a test capsule whose design takes into account the operating requirements of a typical heat source. In addition to indicating the suitability of the reference capsule for ground test, the data generated will be used to validate presently accepted design approaches and define margins that would actually exist for high temperature capsules intended for flight systems. Progress is reviewed on the following tasks: program management; process development; fabrication and assembly; capsule creep testing; coupon compatibility and coating development; and soil burial tests. NSA

**N69-12907#** Atomics International, Canoga Park, Calif.
**LARGE RADIOISOTOPE HEAT SOURCE CAPSULE PROGRAM. TOPICAL REPORT NO. 4: T-111 PRESSURE VESSEL DEVELOPMENT AND FABRICATION**
J. S. Williams and P. B. Ferry 25 Jul. 1968 63 p ref
(Contract AT(29-2)-2338)
(AI-AEC-12712) Avail: CFSTI

The Large Radioisotope Heat Source Capsule (LRHSC) Program is developing technology for high temperature (2000°F) long life (5 years or longer) heat sources which can be used in the space environment. The LRHSC program is specifically concerned with the development of a tantalum alloy fuel capsule. Data are to be obtained under conditions of biaxial creep, impact and burial, and included strain, compatibility and thermal maps. Results for the critical process of deep drawing the tantalum alloy T-111 are presented. Since this process represents a "first" for such extreme l/d ratios with the T-111 alloy, close documentation of the process has been conducted. Details of tooling development and checkout, and the history of problems and solutions encountered during the development effort are given. At this point, the process can be considered "state-of-the-art". Author (NSA)

**N69-12920#** Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
**CRITICALITY OF THE LIQUID MIXTURES OF HIGHLY-ENRICHED UF AND HF [CRITICITE DES MELANGES LIQUIDS D'HEXAFLUORURE D'URANIUM TRES ENRICHI ET D'ACIDE FLUORHYDRIQUE]**
Robert Caizergues, Edouard Deilgat, Pierre Lecorche, Louis Maubert, and Henri Revol Apr. 1968 88 p refs in FRENCH
(R-68.1; NP-17606) Avail: CFSTI

Critical mass is determined for a $UF_6$–HF mixture as a function of $^{235}U$ concentration; the liquid-vapor equilibrium is established for the system. Schematics of the $UF_6$–HF circuit are shown; experimental apparatus is described. Density of the binary system is tabulated as a function of temperature; critical uranium concentration is shown as a function of temperature. Variation of the effective multiplication coefficient is shown as a function of sphere diameter. Effects of the wall of the sphere and temperature effects on the reactivity of the mixture are determined. NSA

**N69-12926#** Rocky Flats Div., Dow Chemical Co., Golden, Colo.
**ANGULAR DISTRIBUTION SPECTRA OF GAMMA RADIATION FROM BEHIND A GRAPHITE BARRIER WITH A SOURCE WITH A PRIMARY ENERGY OF 4.45 MeV**
V. G. Zolotukin, B. A. Efimenko, E. C. Matucevich, and C. C. Omarov [1968] 6 p ref Transl. into ENGLISH from Atomnaya Energ. (Moscow), v. 24, no. 1, 1968 p 75–76
(RFP-TRANS-51) Avail: CFSTI

The angular distribution of gamma radiation emitted from a graphite block enclosing a Po–Be source was measured by means of the isotropic flux scintillation detection of gamma radiation caused by neutron inelastic scattering. NSA

**N69-12927#** Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
**TUBULAR FUEL ELEMENT WITH INTEGRAL TARGET: PCTR EXPERIMENT**
R. A. Bennett, D. F. Newman, A. D. Vaughn, L. C. Davenport, D. E. Robertson et al 1 Jun. 1968 72 p refs
(Contract AT(45-1)-1830)
(BNWL-834) Avail: CFSTI

Two tubular fuel elements with integral target lattices have been investigated in the Physical Constants Test Reactor (PCTR). Multiplication constants, neutron utilization ratios, fast fission factors, and initial conversion ratios have been inferred from null reactivity experiments and measurements of spatial distributions of neutron reaction rates. Both wet and dry experiments were carried out in a three-by-three array of lattice cells 37.5" long placed in the cavity of the PCTR. Author (NSA)

**N69-12930#** Sandia Corp., Albuquerque, N. Mex.
**ANNULAR CORE PULSE REACTOR (ACPR) PULSE BUILDUP TESTS**
J. B. Rivard and F. A. Hasenkamp Aug. 1968 36 p refs
(Contract AT(29-1)-789)
(SC-DR-68-501) Avail: CFSTI

A test program is described during which the Annular Core Pulse Reactor (ACPR) was brought to a performance level which produces a peak fuel temperature of 900°C, the planned initial operating limit. The test plan and the temperature analysis method are described, and detailed results of the tests are reported. Author (NSA)

**N69-12944#** Battelle Memorial Inst., Columbus, Ohio.
**A FAILURE-RESISTANCE EVALUATION OF PLUTONIUM-238 DIOXIDE MICROSPHERES UNDER SIMULATED ENVIRONMENTAL CONDITIONS**
Daniel F. Askey Aug. 1968 28 p refs Prepared for Sandia Corp., Albuquerque, N. Mex. Supported in part by AEC
(SC-CR-68-3640) Avail: CFSTI

The resistance of $^{238}PuO_2$ microspheres to spallation and fragmentation under environmental conditions simulating isotopic-heat source catastrophic failure under reentry was evaluated. Small test samples of uncoated microspheres were subjected to a helium environment at 1300°F and 2500 psi and rapidly depressurized in time periods as short as 25 millisec with no apparent loss of particle integrity. Author (NSA)

**N69-12982#** Los Alamos Scientific Lab., N. Mex.
**A MULTILEVEL ANALYSIS OF THE U 235 FISSION CROSS SECTION**
James D. Cramer 16 Apr. 1968 9 p refs
(Contract W-7405-ENG-36)
(LA-3917) Avail: CFSTI

Resonance parameters for the $^{235}U$ fission cross section, as measured on the Petrel experiment at the Nevada Test Site, were determined using a multilevel fitting program based on the Wigner–Eisenbud R-Matrix theory. Author (NSA)

**N69-12984#** Institutt for Atomenergi, Kjeller (Norway).
**PIGG: A MULTIGROUP ONE-DIMENSIONAL P-1 CODE**
J. O. Berg, G. E. Fladmark, T. Kulikowska, and O. P. Tverbakk May 1968 85 p refs
(KR-129) Avail: CFSTI

A complete description of the multigroup, one-dimensional P-1 code PIGG, coded in FORTRAN-63 for the CDC-3600 computer is presented. PIGG is in many respects similar to the PIMG-code, but some significant features are different. PIGG is intimately connected with the epithermal spectrum part of the BIGG II code and applies the same slowing down model, resonance absorption treatment, number of energy groups and epithermal cross section library. Up to six thermal energy groups may be used in PIGG, with precalculated group constants and scattering matrices as input. The PIGG input has been designed to permit both flexible and easy use of the code. The output is very extensive and includes a.o. pointwise group spectra and macrogroup constants, region-averaged macrogroup constants, and epithermal reaction rates for selected elements. Author (NSA)

**N69-13036#** Aktiebolaget Atomenergi, Stockholm (Sweden).
**HYDRODYNAMIC AND HEAT TRANSFER MEASUREMENTS ON A FULL-SCALE SIMULATED 36-ROD MARVIKEN FUEL ELEMENT WITH UNIFORM HEAT FLUX DISTRIBUTION**
O. Nylund, K. M. Becker, R. Eklund, O. Gelius, I. Haga et al 1967 114 p refs
(FRIGG-2) Avail: CFSTI

A series of experiments was performed in the 8 MW FRIGG loop with a uniformly heated 36-rod cluster, simulating a fuel element for the Marviken boiling heavy water reactor. The cluster consisted of rods with 4.4 m heated length and 13.8 mm outer diameter. In addition an unheated center rod of 20 mm diameter was present. Prototype reactor spacers were used. The investigations include the single- and two-phase pressure drops, the axial and radial void distributions, burnout in natural and forced circulation, the natural circulation mass velocity, the stability limit, and the details about the system during transient conditions. The pressure was 50 bars. The results are compared to data obtained in previous 6-rod tests and to predictions with existing correlations and models. Author (NSA)

**N69-13037#** Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
**NPTR TERTIARY REACTIVITY CONTROL SYSTEM**
S. L. Engstrom and H. C. F. Ripfel Apr. 1968 15 p
(Contract AT(45-1)-1830)
(BNWL-767) Avail: CFSTI

A tertiary reactivity control system for the NPTR is described. The type of shutdown rod investigated consists of a blade rod of $B_4C$ with a canned sodium section. The rods will move in rectangular guide tubes driven by electric motors and worn gears. Analyses of flooding accidents and achievable rod worths indicate that ample negative reactivities can be provided by this blade rod system. Author (NSA)

**N69-13038#** Kernforschungszentrum, Karlsruhe (West Germany).
**AN ANALYSIS OF TWENTY FOUR ISOTOPES FOR USE IN MULTIPLE FOIL (SANDWICH) MEASUREMENTS OF NEUTRON SPECTRA BELOW 10 KeV. RECOMMENDED RESOLVED AND STATISTICAL RESONANCE PARAMETERS FOR TWENTY FOUR ISOTOPES**
T. J. Connolly, F. de Kruijf, and J. J. Schmidt Apr. 1968 147 p refs
(KFK-718; EUR-3716.e; EURFNR-527) Avail: CFSTI

The results of an analytical investigation of the characteristics of various isotopes for use as sandwich foil detectors in various spectra are presented. The predicted magnitudes of the activation differences between designated foils of a sandwich are given, together with the contributions to the activation difference from one or more individual resonances. Doppler-broadened capture resonance integrals are tabulated by resonance for several isotopes; recommended resolved and statistical resonance parameters for 24 isotopes are also listed. NSA

**N69-13042#** Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt.
**HBWR QUARTERLY PROGRESS REPORT, APRIL–JUNE 1968**
Aug. 1968 224 p refs
(HPR-102) Avail: CFSTI

Halden Boiling Water Reactor (HBWR) operations are summarized. Work discussed includes; failure detection by gas sampling in HBWR reactor fuel elements; assemblies of Zircaloy 2-clad uranium oxide and plutonium oxide–uranium oxide; fission product activity analysis in HBWR coolant loop; and development program for HBWR digital computer reactor control system. NSA

**N69-13043#** Academia R. P. R., Bucharest. Inst. De Fizica Atomica.
**METHOD FOR COLLAPSING FAST-REACTOR CROSS SECTIONS**
M. Pavelescu, V. Anton, and I. Purica 1968 22 p refs
(IFA-FR-68) Avail: CFSTI

The critical size calculation of a fast reactor in a multigroup approximation is easier if the group number is small (1 to 4 group). This requires the microscopic cross sections averaged on the energy groups and weighted on the reactor spectrum. The spectrum has to be calculated, and if it is calculated in a middle group set (16 to 20 group) the average microscopic cross sections for a few group set can be determined. Author (NSA)

**N69-13044#** Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
**DECAY HEAT DEPOSITION FROM IRRADIATED FTR FUEL BUNDLE**
W. L. Bunch 5 Dec. 1967 29 p refs
(Contract AT(45-1)-1830)
(BNWL-648) Avail: CFSTI

A preliminary evaluation of the decay energy distribution pattern in the FTR driver fuel bundle for determining the adequate cooling requirements in handling or storage is presented. Calculated decay heat plots for fuel operation at a fission power level of 5MW to 45 MWD/kg are presented. Estimated axial distribution along the fuel region is shown. NSA

N69-13047# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
**SAFETY ANALYSIS REPORT, ADVANCED TEST REACTOR**
D. R. deBoisblanc and S. Cohen Apr. 1965 306 p refs
(Contract AT(10-1)-205)
(IDO-17021-Rev-Vol-1) Avail: CFSTI

Information on the Advanced Test Reactor (ATR) is given under the following broad headings: introduction and summary; ATR site; reactor building; reactor structure, shielding, and equipment; reactor core; primary coolant system; and instrumentation and control. NSA

N69-13050# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics.
**RADIATIVE CAPTURE AND NEUTRON TOTAL CROSS SECTION FOR SELENIUM ISOTOPES**
Kh. Maletski, L. B. Pikel'nev, I. M. Salamatin, and E. I. Sharapov 1968 25 p refs In RUSSIAN
(JINR-P3-3956) Avail: CFSTI

Radiative capture and transmission measurements were carried out on enriched Se isotopes, using the pulsed reactor IBR with a microtron. Level parameters were obtained in the energy range up to 10 to 20 keV for four even isotopes and up to 4 keV for an odd isotope. Spins were measured for 15 levels with $\Gamma_n' > \Gamma_\gamma'$ for $^{77}$Se. Strength functions $S_0$, average level spacing, and average radiation widths $\bar{\Gamma}_\gamma$ were obtained. The spin dependence of $S_0$ and $\bar{\Gamma}_\gamma$ for $^{77}$Se in the energy interval up to 4 keV was not observed. Author (NSA)

N69-13078# Israel Atomic Energy Commission, Tel Aviv.
**NUCLEAR SPECTROSCOPY USING RESONANCE SCATTERING OF CAPTURE GAMMA RAYS AT THE IRR-2 RESEARCH REACTOR**
Y. Schlesinger, B. Arad, and G. Ben-David Jan. 1967 37 p refs
(IA-1097) Avail: CFSTI

Studies of resonant scattering of capture gamma rays were carried out at a tangential beam tube at the IRR-2 reactor, using high-intensity gamma sources adjacent to the reactor core. The high fluxes of monoenergetic gamma rays available permitted the use of high-resolution germanium counters for studying elastic and inelastic transitions, thus giving information on decay schemes and on nuclear level parameters. Author (NSA)

N69-13127# United Kingdom Atomic Energy Authority, Harwell (England).
**THE HARWELL SCATTERING LAW PROGRAMME: FREQUENCY DISTRIBUTIONS OF MODERATORS**
D. I. Page and B. C. Haywood May 1968 33 p refs
(AERE-R-5778) Avail: Issuing Activity

The frequency distributions of moderators at various temperatures measured by the Harwell–Chalk River Scattering Law Project are tabulated and shown graphically. References are given to the best available experimental data from which the distributions are derived. The methods used to estimate the correction factors for the data are indicated in each case. Author (NSA)

N69-13129# United Kingdom Atomic Energy Authority, Harwell (England).
**A NONDESTRUCTIVE MEASUREMENT OF THE FLUCTUATIONS IN AREA DENSITY OF A GRAPHITE BLOCK USING A 147-MeV PROTON BEAM**
Ronald A. Bell, P. J. Clements, and A. Langsford May 1968 11 p refs
(AERE-R-5732) Avail: Issuing Activity

The fluctuations in area density (mass per unit area) over a disc of high density graphite, 45 mm diameter and 14 mm thick, were measured using a 147 MeV proton beam as a nondestructive probe. An accuracy of ± 0.08 kg m$^{-2}$ at each point, and a spatial resolution of 3 mm was obtained. It was concluded that the technique is capable of giving, for samples up to 100 to 200 kg m$^{-2}$ thick, an accuracy of ± 0.003 kg m$^{-2}$ or ≈ 1% of the value of the fluctuation, whichever is the greater, and a spatial resolution of less than 1 mm. For the thickest targets the method is potentially ≈ 100 times more accurate than standard methods based on the transmission of radiation from radioisotopes. Author (NSA)

N69-13140# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
**EVALUATION OF NPTR/FTR NEUTRONICS DIFFERENCES**
G. L. Baird and S. L. Engstrom 8 Apr. 1968 20 p
(Contract AT(45-1)-1830)
(BNWL-762) Avail: CFSTI

The degree of simulation of the FTR neutronics characteristics achieved by the NPTR reference design is described. The neutron flux spectrum and $K_{eff}$ of the systems are indicators of system changes. Parameters such as the Doppler coefficient, reaction rates of $^{239}$Pu fission, and boron absorption are considered. The differences in reactivity worths calculated for the FTR system and NPTR system are also important sensors. Author (NSA)

N69-13147# Oak Ridge National Lab., Tenn.
**MOLTEN-SALT REACTOR PROGRAM Semiannual Progress Report, Period Ending 29 Feb. 1968**
Aug. 1968 282 p refs
(Contract W-7405-ENG-26)
(ORNL-4254) Avail: CFSTI

Continuing research on molten salt nuclear reactors is reported. Topics include MSRE fuel chemistry and processing, fuel salt preparation, development of primary structural materials, reactor safety, and radiation performance of fuels, structural materials, and coolants. Detailed studies were conducted on protactinium removal from a single fluid MSBR and fluorination techniques for fuel recovery. Irradiation analyses of graphite and Hastelloy N materials were made. A study of the neutronic properties of an MSRE system using U233 fuel was concluded, as well as investigations into abnormal situations which could lead to nuclear excursions. Analyses of a MSBR system demonstrated that the nuclear performance of a single fluid reactor could be as attractive as that of specific two fluid reactors. Electric conductivity and thermodynamic measurements were made of molten fluoride systems. A.C.R.

N69-13149# Atomic Energy of Canada Ltd., Sheridan Park (Ontario).
**HEAT TRANSPORT PUMPS**
R. H. Renshaw Jul. 1968 23 p Presented at Joint CNA-ANS Conf., Toronto, 10–12 Jun. 1968
(AECL-2713) Avail: CFSTI

The coolant, usually water, is circulated through the core of a nuclear reactor by pumps which operate at high temperature and pressure. They operate in areas not accessible during plant operation. Power plant reliability depends on continuous operation of this heat transport system. Most pumps are vertical single-stage, single suction, electrically driven designs. This type is chosen for compactness and symmetry and because it has only one shaft seal. Its disadvantage is that the rotating assembly presents a complex bearing problem which is described. The shaft seal is critical. Several well developed designs for this service are believed reliable and should have a seal life of 25,000 hours. Leakage, which is collected, should not be more than a few gallons per minute. Size, availability and manufacturing problems are discussed. Experience with pumps in service to date with an examination of probable causes of failure is considered in some detail as well as future projections for large pumps up to 7200 hp. Author (NSA)

N69-13153# IIT Research Inst., Chicago, Ill.
**DEVELOPMENT OF NEUTRON SPECTROMETRY FOR CRITICAL ASSEMBLIES Final Report, 29 Jun. 1966–30 Sep. 1967**
Robert B. Moler and W. E. Zagotta Aug. 1968 95 p refs
(Contract AT(11-1)-578)
(IITRI-578P31-2) Avail: CFSTI

The design, construction, and preliminary testing of two neutron spectrometer concepts are discussed. One spectrometer, based on the proton recoil technique and intended for in-core measurements in nuclear reactor critical assemblies, incorporates an annular ring of proportional counters surrounding a wall-less central counter. By operating the ring counters in anticoincidence with the central counter, the gamma sensitivity is reduced by as much as a factor of 100 without any significant effect on the neutron sensitivity (for neutron energies less than about 100 keV). The other spectrometer is a $^3$He-sandwiched spectrometer which uses the $^3$He converter gas as the filling gas for two identical wall-less proportional counters. This spectrometer is relatively insensitive to gamma rays, compensates for the reaction energy lost in the converter material, and discards pulses produced by the neutron-induced interfering reactions which occur in the silicon solid-state detectors and in the $^3$He. Author (NSA)

N69-13156# General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.
**EXTERNAL ELECTRON BEAM IMPULSE HEATING**
S. G. Kovacs 15 Jul. 1968 24 p
(Contract AT(29-2)-656)
(GEPP-40; R-68-ND-17) Avail: CFSTI

The performance capability of an electron beam gun when used as an external, high intensity impulse heating source for controlled flash evaporation of rare earth getter materials such as holmium, samarium, and thulium is discussed. The film substrate used in this investigation was molybdenum; evaporation temperatures were in the 830° to 1030° C range for the time intervals from 2 to 30 seconds. The performance capability is given in terms of electron beam equivalent temperature parameters for: repeatability on day-to-day basis; resolution; control accuracy; and eight-hour operation stability. The electron beam gun is capable of providing temperature increase rates ranging from 100° to 3000° C per second. Author (NSA)

N69-13157# Gulf General Atomic, San Diego, Calif.
**IRRADIATION-INDUCED DIMENSIONAL CHANGE IN BORONATED GRAPHITE CONTROL ROD ABSORBERS FOR THE FORT ST. VRAIN HTGR**
O. M. Stansfield 19 Jun. 1968 21 p refs
(Contract AT(04-3)-633)
(GAMD-8619) Avail: CFSTI

Dimensional change in neutron irradiated boronated graphite is probably due primarily to a complex interaction of effects from fast neutron damage, thermal neutron capture by $^{10}$B, and swelling of $B_4C$ particles. A model for $^{10}$B burnup and dimensional change in a typical absorber compact is developed taking into account effects of a $^{10}$B burnup gradient and interaction of resulting damage zones. Use of the model in conjunction with irradiation data made possible an estimate of dimensional change in a Fort St. Vrain absorber compact (40 wt % boron) for 6 years service at 50% and 100% duty factors. In both hot molded and extruded compacts, expansion is more probable than contraction in any direction at 6 years of continuous exposure. For hot molded compacts, expansion of 5.0% and 0.5% may occur in the axial and radial directions, respectively. With extrusions, 1.0% and 2.0% expansion can be expected in the axial and radial directions, respectively. At 50% duty factor, there will be less expansion in all cases, and perhaps some radial contraction for hot molded compacts. . . . Author (NSA)

N69-13163# Battis Atomic Power Lab., Pittsburgh, Pa.
**FABRICATION, CHARACTERIZATION, AND THERMAL-PROPERTY MEASUREMENTS OF THORIUM DIOXIDE-URANIUM DIOXIDE FUEL MATERIALS (LWBR DEVELOPMENT PROGRAM)**
J. R. Springer, E. A. Eldridge, M. U. Goodyear, T. R. Wright, and J. F. Lagedrost 1 Oct. 1967 146 p refs Prepared for Battelle Mem. Inst., Columbus, Ohio
(Contracts W-7405-eng-92; AT(11-1)-GEN-14)
(BMI-X-10210) Avail: CFSTI

Thermophysical-property specimens of $ThO_2$, $ThO_2$-10 wt % $UO_2$ and $ThO_2$-20 wt % $UO_2$ were fabricated and characterized. Each material composition was represented by specimens with nominal densities of 95, 85, and 75 percent of theoretical. Thermal-diffusivity, linear-thermal-expansion, and specific-heat measurements were made at 300 to 1900° C and used to determine thermal conductivity. Results of linear-thermal-expansion and specific-heat measurements were approximately the same for all materials. Values of linear thermal expansion ranged up to 2.2 percent in heating from room temperature to 2000° C. The specific heat ranged from 0.055 cal/(g) (C) at 0° C to 0.080 cal/(g) (C) at 2000° C. Thermal-diffusivity values ranged from $3.0 \times 10^{-2}$ cm$^2$ per sec at 300° C to $0.6 \times 10^{-2}$ cm$^2$ per sec at 1900° C. Thermal conductivities decreased in regular fashion with increased $UO_2$ content and porosity. Author (NSA)

N69-13166# Union Carbide Corp., Oak Ridge, Tenn. Gaseous Diffusion Plant.
**SEPARATION OF STABLE ISOTOPES**
Wang Chen [1968] 31 p refs Transl. into ENGLISH from Hua Hsueh Tung Pao (Peking), no. 8, 1963 p 458–468
(K-Trans-38) Avail: CFSTI

The methods used for the separation of stable isotopes are reviewed. They include methods based on the difference in the mass of the isotopes, such as electromagnetic and centrifugal methods; on molecular kinetic characteristics, e.g., diffusion, thermal gradient, molecular distillation, and electrophoretic methods; on thermodynamic properties, such as distillation, chemical exchange, chromatographic absorption, crystallization, and extraction methods; on chemical reaction kinetics of the isotopes, for example, methods based on the kinetic isotopic effect, photochemical properties, and electrolysis. A fifth class, the method based on biological effects, is also reviewed. NSA

N69-13168# Oak Ridge National Lab., Tenn. Nuclear Safety Information Center.
**COMPILATION OF NATIONAL AND INTERNATIONAL NUCLEAR STANDARDS (EXCLUDING U S ACTIVITIES), 4th EDITION, 1968**
William B. Cottrell (U.S. of Am. Std. Inst.) Sep. 1968 75 p refs
(Contract W-7405-eng-26)
(ORNL-NSIC-50) Avail: CFSTI

All known national and international nuclear standards activities are tabulated. Standards activities of all national organizations, technical societies and government agencies are listed alphabetically by country. Standards activities are included for: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Hungary, India, Israel, Italy, Japan, Netherlands, Norway, Pakistan, Republic of South Africa, Sweden, United Kingdon, and Yugoslavia. International organizations activities include: Bureau Veritas, European Organization for Nuclear Research, European Atomic Energy Community, International Air Transport Association, IAEA, International Commission on Radiological Protection, International Commission on Radiation Units and Measurements, International Electrotechnical Commission, Intergovernmental Maritime Consultative Organization, International Organization for Standardization, Lloyds Organization for Economic Cooperation and Development; European Nuclear Energy Agency, and United Nations. NSA

**N69-13175#** Cornell Univ., Ithaca, N. Y. Nuclear Reactor Lab.
**A FAST STORAGE SYSTEM FOR PULSE-HEIGHT DATA AND EXPERIMENTS ON 31-MILLISECOND Gd-155m**
Moshe Etzion (Ph.D. Thesis) Jan. 1968 170 p refs
(Contract AT(30-1)-3864)
(CURL-28; NYO-3864-10) Avail: CFSTI

A fast temporary storage system for pulse amplitudes which was developed for use in pulse height analysis of millisecond half-life isomers is described. The electrostatic system can store about a thousand pulses and has a uniform dead time of 1 $\mu$ sec. Also, experiments on 31-millisecond $^{155m}$Gd are described. The isomer was produced by pulsed neutron irradiation of a sample enriched in $^{154}$Gd in the Cornell TRIGA reactor. Gamma and x ray measurements were performed using Ge(Li) and NaI(Tl) detectors. Energies of 86.2 $\pm$ 0.4 keV and 42.7 $\pm$ 0.45 keV were measured corresponding to the known second excited state of $^{155}$Gd($T_{1/2}$ = 5 nsec) and to gadolinium K x rays. The isomer half-life was determined to be 31.4 $\pm$ 1.5 msec. The K conversion coefficient of the 86.5 keV level was calculated from spectra of both detectors. The results were 0.39 $\pm$ 0.03 for the Ge(Li) spectra and 0.43 $\pm$ 0.03 for the NaI(Tl) spectra. NSA

**N69-13205#** Oak Ridge National Lab., Tenn.
**FAILURE MODES OF ZIRCALOY-CLAD FUEL RODS**
P. L. Rittenhouse 13 Sep. 1968 70 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2347) Avail: CFSTI

The behavior of the Zircaloy-clad $UO_2$ fuel rods during a loss-of-coolant accident in a modern light-water reactor is investigated. Attention is called to the possible detrimental effect of fuel rod failure on the efficiency of the emergency core cooling system and the subsequent chain of events in the accident. Existing programs and data relevant to the accident behavior of these rods are reviewed. Research and testing necessary to resolve the questions on fuel rod behavior are described. Author (NSA)

**N69-13206#** Scientific Research Atomic Reactor Inst., Melekess (USSR).
**ANGULAR MEASUREMENTS OF FRAGMENTS OF FISSION IN AN IONIZATION CHAMBER**
B. G. Basova, O. I. Ivanov, Yu. A. Kushnir, and A. M. Shimanokii 1967 12 p refs In RUSSIAN
(SRARI-P-3) Avail: CFSTI

An angular fission fragment measurement method is developed, which allows the utilization of an ionization chamber for multi-parameter measurements with simultaneous recording of energy and angular fission fragments distributions. Angular resolution is characterized by $(\cos\theta - \cos\theta)^2$ equal to 0.03 at $\theta = 90°$ and 0.06 at $\theta = 0°$. The electronic circuit fast response is characterized by a 20 $\mu$ sec dead time. Author (NSA)

**N69-13214#** United Kingdom Atomic Energy Authority, Harwell (England). Information Branch.
**EXPERIMENTAL STUDY OF THE NEUTRON THERMALISATION PROCESS IN TIME IN HYDROGENOUS MODERATORS**
S. N. Ishmaev et al Jun. 1967 17 p refs Transl. into ENGLISH from Pulsed Neutron Res. Symp., v. 1, p 643–655, Karlsruhe, W. Ger., 10–14 May 1965 Submitted for publication
(AERE-TRANS-1088) Avail: CFSTI

The authors measured non-stationary neutron spectra in zirconium hydride and in water at room temperature as a function of slowing-down time, with a resolution of 3.5 $\mu$s. The spectra measured in a large ZrH prism belong to a range of slowing-down times greater than 30 $\mu$s, in which the mean neutron energy is less than 0.13 eV and the energy exchange between the neutron gas and the medium is caused mainly by the excitation of acoustic lattice vibrations. In this range thermalization proceeds comparatively slowly, and the time required to establish an equilibrium neutron spectrum is of the order of 400 $\mu$s. In a small ZrH assembly, a strong diffusion-cooling effect is observed. The spectra measured with long slowing-down times were found to differ considerably from the Maxwellian distribution according to the temperature of the medium. The time required to establish an equilibrium energy distribution increased with decreasing system size. Neutron energy spectra in water are presented for slowing-down times of over 10 $\mu$s, where distortion due to resolution is negligible. Author (NSA)

**N69-13253#** Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.
**GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report, Feb.–Apr. 1968**
E. H. Dewell, comp. Jul. 1968 57 p refs
(Contract AT(30-1)-3809)
(BAW-3714-7; QPR-7) Avail: CFSTI

Development of the sol-gel process and related processes was continued. Emphasis was shifted to the Oak Ridge mixed sol approach, and development of the gel-addition technique continued at a reduced level. Oxide characterization work continued, and an irradiation program combining thermal and fast exposures was agreed upon. Gel-addition experiments designed to increase the pickup of plutonium by $UO_2$ gels from aqueous solutions were begun; among the procedures tested, homogeneous hydrolytic precipitation of Pu(III) by urea during the pickup step showed the most promise. Pickup in one contact increased to about half the required value for fast reactor fuels. Assay of both plutonium and uranium is now routinely carried out by weight aliquoting and controlled-potential coulometry. Shipper-receiver differences of about 2% in plutonium are still encountered. Author (NSA)

**N69-13255#** European Atomic Energy Community, Ispra (Italy). Reactor Physics Dept.
**A DYNAMIC MODEL FOR THE COOLING CHANNELS OF A BOILING NUCLEAR REACTOR WITH FORCED CIRCULATION AND HIGH PRESSURE LEVEL**
G. Forti Sep. 1968 28 p refs
(EUR-4052.e) Avail: CFSTI

A dynamic model for boiling channels of nuclear reactors is proposed, which is suitable for numerical calculations in the time domain. The model is one-dimensional, and includes treatment of subcooled boiling and liquid superheating. It includes a new form of boiling heat transfer correlations and a correction of Benkoff's slip correlation for diabatic conditions. In the present formulation the model is limited to constant pressure level of the whole system, but an extension to slowly variable pressure is easy in principle. Author

**N69-13263#** Oak Ridge National Lab., Tenn.
**MONAT: A FORTRAN 63 PROGRAM FOR COMPUTING THERMODYNAMIC PROPERTIES OF MONATOMIC IDEAL GASES**
M. H. Fontana Sep. 1968 19 p refs
(Contract W-7405-ENG-26)
(ORNL-4305) Avail: CFSTI

A computer program was written in Fortran 63 for generating tables of thermodynamic properties of monatomic ideal gases, given the spectroscopic constants. The properties computed and presented are the specific heat at constant pressure, entropy, enthalpy referred to 0°K, and free energy functions. This is done for temperatures from 100 to 6000°K in 100°K increments. A sample calculation is presented for monatomic chromium ideal gas, extended to 6000°K. This is compared with seperately published data to 3000°K. Author (NSA)

**N69-13264#** Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.
**POST-IRRADIATION EXAMINATION OF THORIA-URANIA FUEL RODS Quarterly Progress Report, Dec. 1967–Feb. 1968**
W. N. Bishop, C. J. Baroch et al Jul. 1968 16 p refs
(Contract AT(30-1)-3809)
(BAW-3809-3; QPR-3) Avail: CFSTI

The dissolution of thoria-urania fuel was studied, and it was shown that 13 M nitric acid-0.05 M fluoride under reflux was effective for both irradiated and unirradiated material. Nondestructive examination of the fuel rods showed that they were in excellent condition, and in some cases pellets were intact and free to move within the rods. Eight of the 13 rods have been sectioned, and chemical and metallurgical examinations are in progress. Author (NSA)

**N69-13289#** Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
**SPERT PROJECT Quarterly Technical Report, Jul.–Sep. 1967**
T. G. Taxelius, ed., J. C. Haire, and S. G. Forbes Jul. 1968 46 p refs
(Contract AT(10-1)-205)
(IDO-17271) Avail: CFSTI

Reactor kinetic behavior is investigated using a slightly enriched $UO_2$ core under conditions typifying those of commercial pressurized-water power reactors. Bamboozed fuel rod cladding deformation is studied. Fuel performance tests are carried out on encapsulated dry and waterlogged F-type fuel rods. Fission density in F-type $UO_2$ fuel samples is measured. NSA

**N69-13298#** Kernforschungsanlage, Juelich (West Germany).
**SOME PROBLEMS OF LIGNITE GASIFICATION BY MEANS OF HIGH-TEMPERATURE NUCLEAR REACTOR HEAT [UEBER EINIGE PROBLEME BEI DER VERGASUNG VON BRAUNKOHLEN MIT HOCHTEMPERATUR-KERNREAKTOR WAERME]**
K. Kugeler und A. T. Bhattacharyya Aug. 1968 37 p refs In GERMAN
(JUL-554-RG) Avail: CFSTI

A system and a facility for the generation of electric current and gas are described. Data of the speed of gasification of lignite with steam are given in addition to a description of the basic gasification reactions and their dependence on temperature and pressure. The gas composition that can be expected is calculated as a function of the variables. Several possible arrangements of the system are shown. The balances of quantity and energy for the gasification space give a first indication of the amounts of synthesis gas that can be expected and the requirements for heat from the nuclear reactor. A methanol bath for the removal of $CO_2$ and $H_2S$ from the synthesis gas is briefly described. The efficiency of the entire plant is discussed, and prices for the synthesis gas are estimated. Transl. by K.W.

**N69-13303#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**[NUCLEAR REACTOR AND HEAT EXCHANGER THERMAL DYNAMICS]**
14 Aug. 1967 64 p refs Transl. into ENGLISH from AN. BSSR. Vestsi. Ser. Fiz. Tekhn. Navuk. (USSR), no. 4, 1966 p 5–11; 32–43; 44–55; 138
(AD-675920; FTD-HT-23-892-67) Avail: CFSTI CSCL 20/13

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**N69-13304#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CALCULATION OF THE RADIATION INTENSITY OF THE BORON-CONTAINING RADIATION ELEMENT OF THE IRT-2000 LOOP UNIT**
A. K. Krasin et al *In its* Nuclear Reactor and Heat Exchanger Thermal Dynamics 14 Aug. 1967 p 1–12 refs (See N69-13303 03-22)
Avail: CFSTI

The results of calculations aimed at checking the feasibility of using rods containing boron glass fiber (filament diameter 5–7 $\mu$) and placed in the center of the IRT-2000 reactor are presented. The radiation element was made of seven steel tubes (14 mm in diameter), forming a bundle, each tube being filled with boron glass enriched by 90% with $B^{10}$. The glass contained 80% (by weight) of $B^{10}$ enriched to 90%. The calculations yield the optimal $B^{10}$ concentration, the radiation power (the energy absorbed in the reagent), and also the change effected in the reactivity of the reactor by placing of the boron-containing element in the center of the reactor. The calculations demonstrate the feasibility of obtaining a sufficiently high radiation power with this type of element, sufficient for radiation-chemistry research. An effective way of increasing the radiation power is to increase the content of the $B^{10}$ in the fiberglass filaments. In the particular reactor employed, with a neutron flux $\approx 6 \times 10^{12}$ neut/cm$^2$ sec thermal and $\approx 1.4 \times 10^{13}$ neut/cm$^2$ sec intermediate, the reactivity margin was found to be quite high ($\approx 4.2\%$). Author

**N69-13309*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**POINT DEFECT CALCULATIONS IN TUNGSTEN**
Ronald L. Danilowicz Washington Dec. 1968 14 p refs
(NASA-TN-D-4918) Avail: CFSTI CSCL 20B

Calculations were made with a computer code developed for making point defect calculations in body centered cubic metals. A semi-empirical cubic potential based on experimental data was also developed for tungsten for these calculations. The vacancy migration energy for tungsten was calculated. The calculated value of 1.73 electron volts, together with experimental data, suggests that vacancies migrate in stage 3 recovery in tungsten. The formation energies for six possible equilibrium interstitial configurations were also calculated. The ⟨110⟩ split interstitial was the most stable configuration for tungsten with a formation energy of 9.73 electron volts. Author

**N69-13313#** Gulf General Atomic, Inc., San Diego, Calif.
**INTEGRAL NEUTRON THERMALIZATION Quarterly Progress Report, Period Ending 30 Jun. 1968**
J. R. Beyster, G. M. Borgonovi, D. H. Houston, J. U. Koppel, E. L. Slaggie et al 10 Jul. 1968 50 p refs
(Contract AT(04-3)-167)
(GA-8773) Avail: CFSTI

A number of theoretical studies completed during this period are discussed. The final conclusions resulting from the first principles calculation for beryllium are summarized. A theoretical scattering law for $UO_2$ was completed; however, some additional numerical studies remain to be done before this work can be incorporated in the ENDF. A new model for polyethylene is also described, and comparisons between results of this model and experiment are presented. The lattice dynamical model for beryllium oxide was used to calculate a frequency spectrum and a scattering law in the

incoherent approximation. A calculated total cross section for BeO, including coherent elastic scattering, is presented as part of this work. Some recently completed work on multiple scattering in double differential experiments is also described. Author (NSA)

**N69-13384#** Ente Nazionale per l'Energia Elettrica (ENEL), Rome (Italy).
**ON-LOAD CALIBRATION OF THE LATINA CONTROL RODS [TARATURA DELLE BARRE DI CONTROLLO DEL REATTORE DI LATINA A NOCCIOLO IRRAGGIATO]**
G. Bellia, R. Giannini, G. Lesnoni La Parola, T. Marzullo, and M. Paoletti Gualandi Brussels EURATOM Sep. 1968 38 p refs In ITALIAN; ENGLISH summary
(Contract EURATOM-050-65-1 TEGI)
(EUR-4058.i) Avail: CFSTI

To determine the reactivity versus burnup curve in Latina reactor it is necessary to perform reactivity balances and measurements which entail knowledge of the control rod calibration curves. As the burnup progresses, the rod calibration curves gradually deviate from the initial curves, so that the calibrations have to be periodically repeated. Since, for practical and economic reasons, the method employed during the final adjustment of the plant could not be used for on load calibration, the various methods suggested in the technical literature were critically analyzed and, after comparison of their merits, a method was selected for measuring a xenon transient and at the same time determining the calibration curve of a group of control rods. Measurements were carried out at 1100 and 1425 MWd/reactor tonnes. Author

**N69-13419#** Aktiebolaget Atomenergi, Stockholm (Sweden).
**STUDIES OF THE EFFECT OF HEAVY WATER IN THE FAST REACTOR FRO**
L. I. Tirén, R. Hakansson and B. Karmhag Aug. 1968 26 p refs
(AE-330) Avail: CFSTI

Core 9 of the FRO fast critical assembly was diluted with heavy water to 24 vol. per cent, contained in thinwalled copper cans. The report describes measurements of the critical mass and the reactivity coefficient of heavy water in this core. The effect of the heterogeneous core composition on these items is also dealt with. The results are compared with theoretical predictions using several computer codes. Criticality is accurately predicted, but the measured reactivity coefficient of heavy water is about 20% lower than the value obtained with the best available methods, involving the SPENG and DTF-4 programs. The result of bunching measurements, in which the degree of heterogeneity of core composition was changed, is compared with theoretical estimates of the resonance shielding, flux advantage and leakage components of the heterogeneity effect. Author (ESRO)

**N69-13427#** European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center.
**THE MEASUREMENT OF WIGNER ENERGIES ON SOME GRAPHITES WITH A CALORIMETER [DIE MESSUNG VON WIGNER-ENERGIEN AN EINIGEN GRAPHITEN MIT EINEM KALORIMETER]**
G. Kemeny, H. Rother, and G. Von Birgelen Brussels Aug. 1968 20 p refs In DUTCH; ENGLISH summary
(EUR-4036.d) Avail: CFSTI

For purposes of comparison the stored Wigner energies on some types of graphite (two reactor graphites, pyrographite and two vitreous types of carbon) were measured by a direct calorimetric method. The main characteristic of the calorimeter is a constant heat flux with the additional condition of a constant temperature rise. The measurements covered the temperature range 80–500°C. The graphites had been irradiated at 40–70°C and 350–400°C up to an integrated dose of $6.10^{20}$ nvt. The maximum of the liberated energy fluctuated between 1.6–2.5 kJ/°kg according to the type of graphite. Author

**N69-13428#** European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.
**THE INFLUENCE OF ARTIFICIAL ROUGHNESS ON THE INCREASE IN THE CRITICAL HEAT FLUX OF WATER IN RING GAPS UNDER FORCED CONVECTION. PART 1: UNDERCOOLED STATE AT MEASURING SECTION OUTLET [DER EINFLUSS KUNSTLICHER RAUHIGKEITEN AUF DIE ERHOHUNG DER KRITISCHEN WARMESTROMDICHTE VON WASSER IN RINGSPALTEN BEI ERZWUNGENER KONVEKTION. TEIL 1: UNTERKUHLTER ZUSTAND AM AUSTRITT DER MEDSTRECKE]**
E. Burk, W. Hufschmidt, and E. de Clercq Brussels Jul. 1968 79 p refs In ITALIAN; ENGLISH summary
(EUR-4040.d) Avail: CFSTI

The critical heat flux density (burnout) of subcooled water in an annular test section with inner heated smooth and rough tubes under forced convection conditions has been measured. It was found that in the tested range of parameters, densities could be sensitively increased compared with the smooth surface. This increase of critical heat flux density, however, is relatively small compared with the increase of normal convective heat transfer coefficients without surface boiling on identically roughened surfaces. One chapter deals with the measurement of pressure variations in the test section without and with heat supply up to the critical heat flux density. Author

**N69-13450#** Aktiebolaget Atomenergi, Stockholm (Sweden).
**A COMPARISON OF THEORETICAL AND EXPERIMENTAL VALUES OF THE ACTIVATION DOPPLER EFFECT IN SOME FAST REACTOR SPECTRA**
H. Haggblom and L. I. Tirén Aug. 1968 28 p refs Submitted for publication
(AE-331) Avail: CFSTI

Results of activation Doppler measurements on the U238 (n,γ) and U235 (n,f) reactions in the FRO and MSCA fast critical assemblies have been compared with theoretical values. The study covers neutron spectra with median fission energies from 50 to 240 keV. The calculated Doppler effect in U238 in the FRO cores is 20 – 35% lower than the measured values. The sensitivity of the theoretical result with regard to changes in cross sections and neutron spectrum has been studied. The theoretical value for U235 (FRO core 5) is 4 times higher than the measured one. The report includes a brief description of the DORIX-2 method of calculating effective resonance cross sections appropriate to activation Doppler measurements. References to the cross section data used for the comparisons are also given. Author (ESRO)

**N69-13503#** Kernforschungsanlage, Juelich (West Germany).
**RESONANCE INTEGRAL COMPUTATION FOR MULTIPLE-HETEROGENEOUS ARRANGEMENTS [RESONANZINTEGRALBERECHNUNG FUER MEHRFACH HETEROGENE ANORDNUNGEN]**
E. Teuchert and R. Brietbarth Sep. 1968 39 p refs In GERMAN
(JUL-551-RG) Avail: CFSTI

A program for the numerical calculation of the geometric escape probability is presented which is applicable to such multiple-heterogeneous arrangements as, for example, in the case of an absorptive medium imbedded in the core of coated particles contained in spherical or rod-shaped fuel elements. This program is for use in connection with the program ZUT, designed for computing the resonance integral of isolated resonances. The computed resonance integrals are introduced into the epithermal spectral program GAM, whereby it becomes possible to compute the spectrum based on new resonance parameters for multiple-heterogeneous arrangements without undue effort. The complemented program, named ZUT-DG, is written in FORTRAN IV. The mathematical basis is described in detail. Transl. by K.W.

**N69-13521#** Kernforschungsanlage, Juelich (West Germany).
**AN ESTIMATION OF STRENGTH CHANGES IN BeO MODERATOR SPHERES DURING EXPOSURE IN A 1000 MWe SPHERE-PILE REACTOR [EINE ABSCHAETZUNG DER FESTIGKEITSAENDERUNG VON BeO-MODERATORKUGELN BEIM DURCHLAUF DURCH EINEN 1000 MWe-KUGELHAUFENREAKTOR]**
F. E. Buresch, W. Rixen, and R. Hecker Jun. 1968 89 p refs In GERMAN
(SUL-525-RW-RG) Avail: CFSTI

Two model calculations are performed to estimate the changes in strength caused by the anisotropic growth of the BeO crystals and by the formation of helium bubbles and their accumulation at the grain boundaries of the material. It is assumed that the BeO is used in the form of pure moderator spheres in a 1000 MWe pile reactor. Rotation time of the spheres, flux, temperature distribution, and volume expansion are determined, and an equation is derived for the strength calculations which takes into account porosity, elastic constants, thermal rest expansion, irradiation expansion, and surface energy. Transl. by K.W.

**N69-13559#** Naval Research Lab., Washington, D. C.
**IRRADIATION EFFECT ON REACTOR STRUCTURAL MATERIALS Quarterly Progress Report, 1 May–31 Jul. 1968**
L. E. Steele, J. R. Hawthorne, C. Z. Serpan, Jr., Uldis Potapovs, and R. A. Gray, Jr. 15 Aug. 1968 37 p refs
(AD-676315; NRL-MR-1908) Avail: CFSTI CSCL 18/10

The research program of the NRL Metallurgy Division, Reactor Materials Branch, is devoted to the determination of the effects of nuclear radiation upon the properties of structural materials. The overall program is sponsored by the Office of Naval Research, the U. S. Atomic Energy Commission, and the Army Nuclear Power Program. Since research findings which apply to the objectives of one sponsoring agency are also of interest to the others, the overall program progress is reported herein. This report, covering research for the period 1 May-31 July 1968, includes the following: (1) irradiation response of a 4-in. A533-C, Class 2, submerged arc weldment, (2) relative 550F irradiation response of a heavy section A533-B electroslag weldment, (3) special A533-B steel heat for variable radiation embrittlement studies, (4) thermal stability evaluation of Ni-Cr-Mo weld deposits, (5) thermal stability evaluations of 12Ni-5Cr-3Mo maraging steel plate at 550, 650, and 740F, (6) long-term irradiation of pressure vessel steels in the Big Rock Point Reactor, (7) plate directionality characteristics of irradiated LaCrosse reactor pressure vessel steel, and (8) preliminary study of the irradiation response of A537 Grade B steel at less than 250F. Author (TAB)

**N69-13626#** Aktiebolaget Atomenergi, Stockholm (Sweden).
**CALCULATION OF RESONANCE INTERACTION EFFECTS USING A RATIONAL APPROXIMATION TO THE SYMMETRIC RESONANCE LINE SHAPE FUNCTION**
H. Hegblom Aug. 1968 48 p refs Submitted for publication
(AE-329) Avail: CFSTI

The method of calculating the resonance interaction effect by series expansions has been studied. Starting from the assumption that the neutron flux in a homogeneous mixture is inversely proportional to the total cross section, the expression for the flux can be simplified by series expansions. Two types of expansions are investigated and it is shown that only one of them is generally applicable. It is also shown that this expansion gives sufficient accuracy if the approximate resonance line shape function is reasonably representative. An investigation is made of the approximation of the resonance shape function with a Gaussian function which in some cases has been used to calculate the interaction effect. It is shown that this approximation is not sufficiently accurate in all cases which can occur in practice. Then, a rational approximation is introduced which in the first order approximation gives the same order of accuracy as a practically exact shape function. The integrations can be made analytically in the complex plane and the method is therefore very fast compared to purely numerical integrations. The method can be applied both to statistically correlated and uncorrelated resonances. Author (ESRO)

**N69-13632#** Technische Hochschule Stuttgart (West Germany).
**EXPERIMENTS FOR SIMULATING HEAT TRANSFER FROM A REACTOR SURFACE TO CESIUM VAPOR CONVERTORS [VERSUCHE ZUR SIMULIERUNG DER WAERMEUEBERTRAGUNG VON EINER REAKTOROBERFLAECHE AN CS-DAMPFKONVERTER]**
A. Koeppe Bundesministerium fuer Wiss. Forsch. May 1968 17 p ref In GERMAN; ENGLISH summary
(BMWF-FBK-68-18) Avail: CFSTI

Experiments for simulating heat transfer by radiation from a reactor surface to a thermionic converter with a heat pipe-radiator are described. A cesium diode for a SRAST-W system was built and a description in terms of design and data is given. The results of measurement on a front wall heated heat pipe are discussed. Technological problems of a cesium diode by electron beam welding are considered. Author (NSA)

**N69-13633#** Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.
**FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT Quarterly Technical Report, Apr.–Jun. 1968**
D. H. Roy, ed. Sep. 1968 47 p refs
(Contract AT(30-1)-3867)
(BAW-3867-4) Avail: CFSTI

Accomplishments in the development and utilization of a design-oriented, one-dimensional criticality and depletion code applicable to the physics analysis of fast reactors are described. Successful executions of the ultrafine group option in $MC^2$ and 68-group fine version of $MC^2$ are analyzed. The unresolved resonance routine for REGA is presented. Debugging of the modified STRIP and RAIM routines is described. Capabilities and formulation of the REDEP are analyzed. The depletion and fuel management studies for the small core is presented. NSA

**N69-13634#** Kernforschungsanlage, Juelich (West Germany).
**RESULTS OF THE STARTER EXPERIMENTS WITH THE FRJ-1 REACTOR FOLLOWING MODIFICATIONS [ERGEBNISSE DER ANFAHREXPERIMENTE AM REAKTOR FRJ-1 NACH DEM UMBAU]**
H. J. Bormann, G. Meister, and E. Muench Jul. 1968 85 p refs In GERMAN
(JUL-546-RE) Avail: CFSTI

This is a pool reactor for research purposes operating with a water-moderated core and enriched uranium. The presently planned output is 5 MW at a thermal neutron flux in the core on the order of $2.5 \cdot 10^{13}$ n/cm$^2$. The distribution of the coolant flow with respect to the position of the fuel elements was measured on typical core arrangements. Construction of the first critical core configuration with fresh fuel elements resulted in a least-critical core consisting of 18 standard burner elements and 4 special burner elements for holding the control absorbers with a total fuel capacity of 3229 g of U 235. Reactivity measurements were made on a typical operational core configuration consisting of a compact 5 × 6 arrangement of 30 burner elements with 4 trim-turnoff absorbers and a fine-control rod. New nuclear instrumentation insures control of the nuclear reactor's performance starting at $10^{-3}$ W up to the full output of 5 MW. This report also contains measured data on the calibration of the output control channels, the reactivity values of fuels when loaded in different positions, the spatial distribution of the thermal neutron flux density, and the distribution of the statistical weight for a cadmium absorber in the reactor core. Transl. by K.W.

**N69-13697#** Atomic Energy of Canada, Ltd., Chalk River (Ontario).
**THE INTENSE NEUTRON GENERATOR AND FUTURE FACTORY TYPE ION ACCELERATORS**
W. Bennett Lewis Oct. 1968 11 p refs Presented at IEEE-GNS 15th Ann. Meeting, Montreal, 23 Oct. 1968
(AECL-3190) Avail: Atomic Energy of Canada, Ltd., Chalk River: $0.50

Ion accelerators may produce isotopes by direct interaction and, at high enough energies, mesons and hyperons. The challenge of the electrical production of neutrons goes far beyond the isotope market. It challenges the two popular concepts for long term large scale energy, the fast breeder reactor and controlled thermonuclear fusion. For this use about 4% of nuclear generated power would be applied in a feedback loop generating extra neutrons. Competition rests on operating and processing costs. The Intense Neutron Generator proposal now cancelled would have been full scale for such a use, but much further advance in accelerator engineering is required and anticipated. Perhaps most promising is the application of the ion drag principle in which rings of fast electrons are accelerated along their axis dragging ions with them by electrostatic attraction. Due to the much larger mass of the ions they can acquire much higher energy than the electrons and the process could be efficient. Such accelerators have not yet been made but experimental and theoretical studies are promising. Author

**N69-13717#** Nuclear Materials and Equipment Corp., Apollo, Pa.
**IRRADIATION TESTING OF PLUTONIUM DIOXIDE–URANIUM DIOXIDE FUELS Quarterly Report, Jan.–Mar. 1968**
Aug. 1968 17 p
(Contract AT(30-1)-3432)
(NUMEC-3432-44; QR-15) Avail: CFSTI

Capsule Nu-19 containing 5 fuel elements of 20 wt % $PuO_2$–$UO_2$ prepared by coprecipitation and mechanically blending and clad in 316L stainless steel were irradiated in the GETR to 100,000 MWd/t. Coprecipitation fuels were substoichiometric (O/M = 1.98) and mechanically blended fuels were substoichiometric (O/M = 1.98) and stoichiometric. Other as-fabricated parameters are given. Irradiation conditions were 9 kw/ft peak heat generation rate and clad and fuel centerline temperatures of 600°C and 2200°C, respectively. Neutron radiographs of the capsule are shown. Gamma scans are recorded and discussed. The isotopic analysis of irradiated mixed oxide fuel from Capsule Nu-18 is given. Author (NSA)

**N69-13719#** Skoda Works, Pilsen (Czechoslovakia).
**STUDY OF SHORT-LIVED SPATIAL REACTOR KINETICS**
Jaroslav Jurecka [1967] 50 p refs
(ZJE-23) Avail: CFSTI

The spatially dependent kinetic equations for the multiregion reactor are studied. The modal method used is limited by the same assumptions inherent in the diffusion theories and by mathematical approximation used in representing the space-time reactor functions. The solution of the critical case is presented. The convergence of the criticality parameter H and the slow flux for the A–1 reactor as a function of the number of modes is shown and it is compared with the previous results. The concept of a transfer function for a nuclear system is extended to include spatial effects. Theoretical curves calculated for the A–1 reactor are compared with the currently used lumped-parameter transfer function. Author (NSA)

**N69-13719#** Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant.
**SOME CONSIDERATIONS IN REGARD TO THE DEVELOPMENT AND USE OF THE KENO PROGRAM**
E. C. Crume, Jr. 20 Sep. 1968 10 p Presented at Symp. on Neutron Interaction in Arrays of Fissionable Mater., Livermore, Calif.
(Contract W-7405-ENG-26)
(Y-DD-23; CONF-680909-3) Avail: CFSTI

The Monte Carlo computer program KENO is described. The computer program calculates criticality conditions of bare and reflected individual fissile systems and arrays of systems. The program is designed for three-dimensional systems. Author (NSA)

**N69-13721#** Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
**USE OF PLUTONIUM AS NUCLEAR REACTOR FUEL Quarterly Report, 1 Jan.–31 Mar. 1968**
Brussels EURATOM Apr. 1968 70 p refs Transl. into ENGLISH from French rept.
(Contract EURATOM-001-64-1 TRUB)
(EURAEC-2036; EUR-3986; BN-6804-01; QR-17) Avail: CFSTI

Fabrication of the 260 homogeneous fuel rods containing 2% $^{235}U$ and 2.7% $^{239}Pu$ is completed. The results on fuel assessment of the dimensional measurements and the tapping tests are given for the six rods irradiated in the hydraulic conveyor. The swelling of the rods reached several per cent and there is a difference between the homogeneous and heterogeneous rods in composition and volume of gas collected. The dimensional measurements effected before and after irradiation showed that the homogeneous rods had swollen by about 1 to 2%, while the heterogeneous rods had retained their initial dimensions. The maximum power attained in CEB-4 is 800 W/cm. The burn-up ratios are 22500 MWd/t in the homogeneous rod and 18500 MWd/t in the heterogeneous rod. The PANTHER code has been improved by proceeding with the treatment of the heterogeneity in the fast field, the broadening of the resonance of $^{240}Pu$ at 1.06 eV with the temperature, and modifications in the fast library of some isotopes. NSA

**N69-13735#** Bhabha Atomic Research Centre, Bombay. Metallurgy Div.
**KINETICS OF SINTERING OF URANIUM DIOXIDE**
V. K. Moorthy and N. C. Soni 1968 21 p refs
(BARC-346) Avail: CFSTI

A study has been made on the kinetics of sintering of pellets prepared from $UO_2$ powders derived from ADU at different calcination temperatures. The powders were calcined between 500 to 1500°C and the densification characteristics of the pellets made from these were evaluated for different soaking times from 10 to 1000 mts at sintering temperatures between 1000–1500°C. Data were analysed using a single empirical equation. It was found that (1) the progress of sintering, (2) attainment of limiting densities and (3) variation in rates of densification at different temperatures and time can be explained on the assumption that material movement (densification) is governed by the number, nature and energy of crystalline defects in the original powders. Author

**N69-13744#** Bettis Atomic Power Lab., Pittsburgh, Pa.
**PERFORMANCE OF FUEL RODS HAVING 97 PERCENT THEORETICAL DENSITY $UO_2$ PELLETS SHEATHED IN ZIRCALOY-4 AND IRRADIATED AT LOW THERMAL RATINGS (LSBR/LWBR DEVELOPMENT PROGRAM)**
J. T. Engel and H. B. Meieran Jul. 1968 151 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-631) Avail: CFSTI

Two fuel rods in which solid $UO_2$ pellets were sheathed in Zircaloy-4 were irradiated in the MTR reactor pressurized water B-4 loop to study the irradiation swelling characteristics of $UO_2$ fuel rods. These rods were designed with a minimum void volume so that fuel swelling could manifest itself as measurable external dimensional changes, allowing a comparison with the irradiation swelling characteristics previously observed in $UO_2$ fuel plates irradiated to burnups in excess of $30 \times 10^{20}$ fissions/cc. The observed fuel swelling rate for both rods did not contradict those found in the reference $UO_2$ plates. Fuel swelling is now considered to be highly temperature-dependent, and volume increases will be

greater than 0.7% $\Delta V/10^{20}$ fissions/cc at temperatures greater than ≈2500°F. The calculated strains were greater than the measured strains; however, failure of the cladding from excessive strain caused by the fuel growth was calculated within the range of uncertainty of the strain failure criteria. Author (NSA)

**N69-13746#** Bhabha Atomic Research Centre, Bombay (India). Waste Treatment Div.

**INVESTIGATIONS WITH VERMICULITE AS A FIXED-BED ION EXCHANGE MATERIAL FOR TREATMENT OF LOW AND INTERMEDIATE RADIOACTIVE EFFLUENTS AT TROMBAY**

Umesh Chandra, Satya Brat, A. R. Chinoy, and K. T. Thomas 1968 20 p refs
(BARC-340) Avail: CFSTI

Investigations were carried out on various samples of vermiculites obtained from different sources in India, for the treatment of radioactive liquid wastes arising from laboratories and the reactor CIRUS. The best sample, the suitable pH of the influent waste and the chemical form of the vermiculite mineral, for optimum removal of fission products activity, were found and recommended for pilot scale studies. Author

**N69-13778#** General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.

**RADIAL VANE STEAM SEPARATOR DEVELOPMENT, PHASE 2 Quarterly Report, Jul.–Sep. 1967**

R. H. Moen, E. Kies, and J. E. Gifford Oct. 1967 51 p refs
(Contract AT(04-3)-189)
(GEAP-5567; EURAEC-1971; QR-9) Avail: CFSTI

Air water tests of the radial vane separator modules (RVSM-1, -2, and -3) were carried out to check the readiness of these units for steam water tests. The effect of a midvane support on carryover and carryunder was observed during these tests as well as measurements of water levels at various points to check usefulness of various measurement points for reactor tests. Steam water tests of RVSM-1 were carried out which demonstrated good carryover and carryunder performance and pressure drop comparable to FCRV-3. Improvements to the design of the radial vane steam separator for KRB were included in the latest design drawing. Observations of air flow in the plenum of FCRV-4 were carried out to determine directions of flow in the plenum and through the nozzles. Analyses to aid the vibration studies were carried out. A correction to the water level equation for the lower vortex is presented. Author (NSA)

**N69-13779#** Oak Ridge National Lab., Tenn.

**DESIGN PRINCIPLES OF REACTOR PROTECTION INSTRUMENT SYSTEMS**

S. H. Hanauer and C. S. Walker Sep. 1968 95 p refs
(Contract W-7405-eng-26)
(ORNL-NSIC-51) Avail: CFSTI

The protection instrument system of a reactor includes those assemblies of instruments, and only those, whose failure to function when needed would be intolerable. Instruments and control devices not part of the protection system constitute the operation system. The protection and operation system should be as nearly independent as possible. Reliability and performance are both required of the protection system. Reliability depends on quality, redundancy and independence of redundant devices, testing, and freedom from failure caused by an accident. Performance can be affected by validity of signals, the manner in which an accident develops, effects on instruments of the accident environment, and other design problems. Protection system design criteria are discussed. Research, development, and testing related to instruments, system performance, and the prediction and measurement of component and system reliability are described. Author (NSA)

**N69-13801#** Los Alamos Scientific Lab., N. Mex.

**ADVANCED PLUTONIUM FUELS PROGRAM Quarterly Status Report, 1 Apr.–30 Jun. 1968 and Annual Report, FY 1968**

12 Sep. 1968 114 p refs
(Contract W-7405-eng-36)
(LA-3993) Avail: CFSTI

Continuing investigations with advanced ceramic plutonium fuels and sodium technology associated with fast breeder reactor development are reported. Fabrication and characterization of plutonium carbides, nitrides, and oxides are discussed. Stainless steel cladding compatibility with various plutonium compounds is evaluated. Physics measurements are calculated for fast breeder reactors. Neutron radiation effects on reactor fuel elements are analyzed. Author (NSA)

**N69-13823#** Oak Ridge National Lab., Tenn.

**PROMPT NEUTRON EMISSION IN THE MEDIUM EXCITATION FISSION OF URANIUM**

S. C. Burnett (Ph.D. Thesis–Tenn. Univ.) Oct. 1968 101 p refs
(Contract W-7405-eng-26)
(ORNL-TM-2272) Avail: CFSTI

The energetics of the fission of $^{233}U$ induced by 8.5 and 13 MeV protons and of $^{238}U$ induced by 12 MeV protons were studied by means of a three parameter experiment. The time of flight of one fragment was measured in coincidence with the pulse amplitudes produced by both fragments in Si surface barrier detectors. The average number of neutrons emitted from the individual fragments and from both fragments together were obtained as functions of fragment mass and total kinetic energy. The number of neutrons emitted per fragment increased with increasing fragment mass and the sawtooth shape characteristic of neutron emission in low excitation fission was apparent, although the relative depths of the minima in the present cases were reduced. The pre and post neutron emission fragment mass distributions were obtained, together with the fragment energy distributions and mass vs energy correlations. Author (NSA)

**N69-13830#** Atomics International, Canoga Park, Calif.

**LIQUID METAL ENGINEERING CENTER (LMEC) Quarterly Technical Progress Report, Apr.–Jun. 1968**

1968 112 p refs
(Contract AT(04-3)-700)
(LMEC-68-20) Avail: CFSTI

Progress in the development of engineering standards and practices for liquid metal systems and components is reported. Drawings and specifications for reconstruction of the high pressure steam piping system for the Sodium Component Test Installation to obtain performance data on intermediate heat exchangers and steam generators under steady state and transient conditions were completed and fabrication contracts issued. Optimization and preliminary design studies for a large sodium pump and component test installation were completed. A thermal transient flow mixing and control analog computer program for use in the Sodium Pump Test Facility was developed. A site and the requirements for the Sodium Cleaning Facility were selected. Designs for the Seal Test Facility were submitted and the basic test rig for testing gas or oil seals was completed. NSA

**N69-13859#** General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.

**USE OF INSTRUMENTED FUEL ASSEMBLIES FOR THE CORE THERMAL-HYDRAULIC ANALYSIS. GARIGLIANO DEVELOPMENT PROGRAM**

D. Oliva and A. C. Duckart Apr. 1968 201 p refs
(Contract AT(04-3)-189)
(GEAP-5823; EURAEC-2059) Avail: CFSTI

Developmental work on the Garigliano power reactor is reviewed. Tasks discussed include: fuel assembly instrumentation and calibration, fuel elements, ionization chamber sensitivity, flowmeter measurements, measurement of voids and exit steam quality for cooling system, coolant flow rates, power level determinations, neutron flux measurements, and thermal and hydraulic analyses. NSA

# 23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

**N69-12645** Brown Univ., Providence, R. I.
**CALCULATIONS OF HARMONIC GENERATION IN FINITE-AMPLITUDE ACOUSTIC BEAMS**
Frank Ingenito (Ph.D. Thesis) 1967 117 p
Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 68-1471

Two related problems of finite-amplitude wave propagation were considered. A method of calculating the harmonic distortion of an unbounded finite-amplitude plane wave in a viscous fluid was developed. The case of a sinusoidally vibrating source is considered, for which numerical integration of the basic equations is very easy, giving results in agreement with more elaborate treatments, and with experiment. A sinusoidally vibrating circular plane piston, in an infinite rigid baffle, radiating at finite amplitude into a non-viscous fluid was also considered. A perturbation equation for the second harmonic is solved by use of the appropriate Green's function, which is expanded in plane waves, as is the driving term, giving the solution in the form of a complicated integral. The integral is evaluated to obtain the second-harmonic pressure on the axis of the source, the result comparing favorably with experiment. A formal expression is given for the second-harmonic pressure off the axis. Also calculated is the average of the second-harmonic pressure over a circle the same diameter as the source, parallel to it, and centered on the same axis, and the results are compared with the most appropriate experimental values. Dissert. Abstr.

**N69-12732** Utah State Univ., Logan.
**NUMERICAL RESTORATION OF OPTICAL OBJECTS OBSCURED BY DIFFRACTION AND NOISE**
Richard Wayne Harris (Ph.D. Thesis) 1967 228 p
Avail: Univ. Microfilms: HC $10.35/Microfilm $3.00 Order No. 68-2563

The restoration of incoherent optical objects which have been diffracted by an optical system and corrupted by detector and additive background noise is considered. The approach is basically numerical and operates directly on the noisy image and point spread function rather than the Fourier transform of these quantities. Special emphasis is placed on studying the effects of noise and the use of a priori information in the restoration process. Several optimum estimates of the object intensity distribution are considered. Based subetantially on statistics which have been verified in practice, the Baye's, maximum a posteriori, maximum likelihood, and mean square error estimates of the object intensity distribution are obtained. These statistical estimates are compared mathematically and in many cases numerically to other non-statistical estimates formulated from control theory and dynamic programming. Dissert. Abstr.

**N69-12767** Brown Univ., Providence, R. I.
**EXTRINSICALLY INDUCED WAVES IN ELASTIC MATERIALS**
Edward Kyran Walsh (Ph.D. Thesis) 1967 80 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-1514

The propagation of waves induced in a one dimensional elastic non-conductor by a propagating extrinsic discontinuity, i.e., a discontinuity in the fields describing the body force and external heat supply, are studied. We assume first that the induced discontinuity is an acceleration wave and derive an explicit expression for the amplitude of this wave in terms of the velocity of the discontinuity and the material properties. As an immediate consequence of this result we conclude that, under certain conditions, the amplitude of the induced wave becomes infinite; which may mean the formation of a shock wave. Also considered are the propagation of acceleration waves induced in a three-dimensional elastic medium by a propagating extrinsic discontinuity. Explicit relations are derived for the amplitude of the induced acceleration waves in 1) elastic materials neglecting thermodynamic effects, 2) elastic materials which are non-conductors, and 3) elastic materials which are definite conductors. Dissert. Abstr.

**N69-12784** Institut fur Plasmaphysik G.m.b.H., Garching (West Germany).
**SURFACE AND VACUUM PHYSICS INDEX, VOLUME 3, NO. 6 (677-853)**
D. Hilsenbeck, ed. Frankfurt am Main, W. Ger. Zentralstelle fuer Atomkernenergie-Dokumentation 1968 94 p refs
(NP-17616) Avail: CFSTI

One-hundred and seventy-six references on various aspects of surface and vacuum physics are listed. Subject and author indexes are included. NSA

**N69-12839** Utah State Univ., Logan.
**ESTIMATION AND DETECTION OF OPTICAL SIGNALS DISTORTED BY DIFFRACTION, BACKGROUND NOISE, AND DETECTION NOISE**
Mark Clarence Austin (Ph.D. Thesis) 1967 227 p
Avail: Univ. Microfilms: HC $10.35/Microfilm $3.00 Order No. 68-2553

The problems of estimating and detecting optical signals which have been distorted by diffraction, additive background noise, and multiplicative noise (detection noise) are studied. Poisson statistics are assumed throughout this paper since they are more realistic in many real situations than the more commonly used Gaussian statistics. Under the assumptions that the output of the detector is a Poisson process, that the signal and noise are additive, and that they have prescribed means and covariance matrices, the optimum linear estimate of the optical signal or object is obtained. In the physical detection process, the interaction between the impinging radiation and the detector produces a sort of multiplicative effect called multiplicative noise. This multiplicative noise is also taken into account in obtaining the optimum linear estimate of the object. Dissert. Abstr.

**N69-12991** Aerodynamische Versuchsanstalt, Gottingen (West Germany).
**MEASUREMENTS OF THE NOISE OF AIR JETS FROM SLOT NOZZLES WITH AND WITHOUT SHIELDS [SCHALLMESSUNGEN AN LUFTFRIESTRAHLEN AUS SCHLITZDEUSEN MIT UND OHNE ABSCHIRMUNG]**
1968 15 p refs In GERMAN; ENGLISH summary Presented at 6th Cong. of the Intern. Council of the Aeron. Sci., Munich, 9–13 Sep. 1968
(ICAS-Paper-68-33; G-61) Avail: CFSTI

Air jets flowing out from slot nozzles generate sound of higher frequencies and have shorter turbulent mixing zones than jets from circular nozzles of equal exit area. This suggests that a

reduction of jet noise should be possible by shielding the jet with suitable reflectors. Measurements have been conducted in the acoustic far field of cold air jets from slot nozzles of about 1 $cm^2$ exit area. The Mach number was Ma = 0.98. Flat plates were used as acoustic shields. The influences of the length of the shield and of the distance between shield and jet axis have been investigated. If the distance between shield and jet is low, additional noise, which reduces the shielding effect, is produced at the end of the shield. Author

**N69-13067** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**PHYSICAL ACOUSTICS**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 47-51 refs (See N69-13060 03-34)
(Contracts N00014-67-A-0204-0019; DA-28-043-AMC-02536(E)) Avail: CFSTI

Physical acoustic experiments are reviewed. The possibility of using optical heterodyne spectroscopy was examined to determine the spectrum of light scattered by thermal fluctuations of a liquid surface. Measurement of the conditional probability for the arrival of a second photoelectron at a time removed from the arrival of the first photoelectron was attempted to determine the surface phonon lifetime of light scattered by a liquid surface in a wavelength region where classical spectroscopy cannot resolve the spectrum. The photoelastic and acoustic properties of $LaF_3$ and CdS were investigated. The sound pressure variation along a duct with a particular type of boundary lining was calculated. B.P.

**N69-13123*#** National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
**COMPUTER PROGRAM FOR EVALUATION OF OPTICAL THIN-FILM FILTERS WITH A DIGITAL COMPUTER AND DISPLAY**
R. R. Bilderback Oct. 1968 23 p
(NASA-TM-X-58013-A) Avail: CFSTI CSCL 20F

The computer program is designed to display and evaluate the comparison of multilayer, dielectric, thin-film optical filter transmittance values with corresponding wavelength data for normal incidence only. The program is written for the PDP-5 and PDP-8 combined computer system which has an intercommunication buffer, a 30-G cathode ray tube display, a deck tape system, and teletype and punched-tape input and output equipment. Author

**N69-13370#** Central Mechanical Engineering Research Inst., Durgapur (India).
**SOME DESIGN ASPECTS OF ULTRASONIC EQUIPMENT**
Pal Gregusa, Jr. Jun. 1968 53 p refs
(M6) Avail: CFSTI

Basic principles of generation and propagation of ultrasonic vibrations, and various aspects of ultrasonic equipment designing are discussed. The possibilities of some new applications of ultrasonics in engineering are implied. Author

**N69-13411#** California Univ., Berkeley. Dept. of Physics.
**POLARIZATION OF F-19 IN Tm-2+ CALCIUM DIFLUORIDE IN OPTICAL PUMPING**
W. B. Grant, R. L. Ballard, and L. F. Mollenauer 24 Jun. 1968 30 p refs
(Contract AT(11-1)-34)
(UCB-34-P-20-2) Avail: CFSTI

In a crystal of $CaF_2$ containing 0.05% $Tm^{2+}$, a significant enhancement of the $^{169}Tm$ nuclear polarization by optical pumping was achieved earlier. In this report, the method is extended to polarize the abundant $^{19}F$ nuclei by a three-spin cross-relaxation process involving a mutual flip of an $^{19}F$ nucleus and two polarized $Tm^{2+}$ ions. Enhancements of 40 are observed for $^{19}F$ and explained by cross-relaxation theory. Author (NSA)

**N69-13424#** Aeronautical Research Council (Gt. Brit.).
**THE INFLUENCE OF GAS STREAMS AND MAGNETIC FIELDS ON ELECTRIC DISCHARGES. PART 4: ARCS MOVING ALONG STRAIGHT PARALLEL ELECTRODES**
V. W. Adams 1968 47 p refs Supersedes RAE-TR-67077; ARC-29302; see N68-13090
(ARC-CP-987; RAE-TR-67077; ARC-29302) Avail: CFSTI

Earlier work with the self-field due to the arc current in the electrodes in the same direction as the applied magnetic field has been extended to include results with fields up to 1.0 $Wb/m^2$. Results are also given for three electrode materials with electrical connections arranged so that the self-field is eliminated, and are shown to differ from those where the self-field is present and approximately calculated. A method, employing similarity parameters given by Dautov and Zhukov of collating data on arc motion in transverse magnetic fields is used to compare results for the present series of reports with other published data, and is shown to be effective for a wide range of parameters from eleven different papers, including the present results. Arc motion with a low-velocity imposed air flow along and relative to the electrodes has been studied, and the simple notion that the algebraic difference between the arc velocities relative to the electrodes in still and moving air is equal to the imposed air velocity is found to be only approximately true when the air stream acts against the arc motion. Author (ESRO)

**N69-13512#** Syracuse Univ., N. Y. Dept. of Chemistry.
**FLUCTUATION PHENOMENA AND PHASE TRANSITIONS IN CONDENSED SYSTEMS Annual Technical Report, 1 Oct. 1967-15 Oct. 1968**
Harry Brumberger 23 Oct. 1968 17 p refs
(Contract Nonr-669(19))
(AD-676890; TR-4) Avail: CFSTI CSCL 20/12

The scattering of light by $BaTiO_3$ near the critical Curie point is described as a function of temperature. An inverse fourth-power relationship is found for the intensity, implying a long-ranged correlation function. The X-ray scattering of quartz near the alpha-beta transition is found not to show any unusual increase, in distinction to light-scattering observations. Fluctuations in anisotropy may account for this behavior. Author (TAB)

**N69-13541#** Ion Physics Corp., Burlington, Mass.
**HIGH VOLTAGE BREAKDOWN STUDY Quarterly Progress Report, 16 Feb.-15 May 1968**
W. R. Bell, M. J. Mulcahy, F. Y. Tse, and A. Watson Oct. 1968 50 p
(Contract DA-28-043-AMC-00394(E); ARPA Order 517)
(AD-676842; ECOM-00394-14; QPR-14) Avail: CFSTI CSCL 20/3

The results of nine further treatments are reported from a 32-block, 5-factor, full-factorial experiment now underway to investigate the main effects and interactions of the following factors: anode and cathode material (copper and aluminum), electrode treatment (hydrogen or vacuum fired), anode size and shape (Bruce or sphere). By a process of stacking, the effect of a transverse magnetic field, exposure and energy storage will also be investigated. Author (TAB)

**N69-13823** Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.
**REFLECTIONS ON TEMPORAL IRREVERSIBILITY [REFLEXIONS SUR L'IRREVERSIBILITE TEMPORELLE]**
R. Lestienne 6 Aug. 1968 31 p refs In FRENCH *Its* Notas de Fisica, Vol. 14, No. 3
Avail: CFSTI

A philosophical treatment of entropy of macroscopic systems is presented. The time-space reflections of Kant, Bergson, Newton, Boltzmann, and others are discussed in relation to irreversibility of systems. Transl. by B.P.

**N69-13644#** Atomic Energy of Canada, Ltd., Chalk River, (Ontario).
**FOCAL LENGTHS AND PRINCIPAL-PLANE POSITIONS OF QUADRUPOLE DOUBLET AND TRIPLET LENSES**
N. Bezic and A. M. Malecki Aug. 1968 109 p refs
(AECL-3160; FSD/ING-138) Avail: Atomic Energy of Can., Ltd., Chalk River: $1.50

The report consists of a collection of graphs showing the variation with lens strength of the focal lengths and the positions of the principal planes for doublet and symmetric-triplet quadrupole lenses. On each sheet curves of one of the quantities studied have been plotted against the strength of the first lens component for a number of values of the strength of the second lens component. Curves for different ratios of component lengths and spacings appear on different sheets. Author

**N69-13701#** Weapons Research Establishment, Salisbury (Australia).
**CALCULATION OF TEM TRANSMISSION LINE PARAMETERS BY FINITE-DIFFERENCE COMPUTATION OF ELECTRIC FLUX**
D. H. Sinnott Aug. 1968 20 p refs
(TN-PAD-152) Avail: CFSTI

The parameters of TEM mode transmission lines are conveniently calculated by using a finite difference potential solution of the cross section to compute the electric flux across a contour. The application of Gauss Theorem leads to an approximate capacitance/length and hence TEM mode parameters. By investigating the connection between this method and an alternative method involving the computation of electrostatic energy, it is shown that the Gauss Theorem solution and energy solution gives the same result when the finite difference equations are exactly solved. Author

**N69-13780#** Cornell Univ., Ithaca, N. Y. Materials Science Center.
**THE F CENTER IN CESIUM FLUORIDE: OPTICAL ABSORPTION PROPERTIES**
T. A. Fulton and D. B. Fitchen Aug. 1968 63 p refs
(Contract AT(30-1)-3464)
(NYO-3464-14; REPT-996) Avail: CFSTI

Studies of the well resolved triplet line shape of the F band in cesium fluoride and its temperature dependence, magnetic circular dichroism, and stress induced behavior are reported. The results are in accord with the picture proposed by Moran, in which the triplet structure results from a combined spin orbit coupling and Jahn–Teller effect in the excited states, although an accurate numerical calculation of the line shape predicted by his adiabatic model shows certain features not found experimentally. The circular dichroism results show that the contribution of the $\Gamma_{1g}$ lattice modes to the F band second moment is ~15%. NSA

**N69-13878#** Oklahoma State Univ. Research Foundation, Stillwater.
**WAVE PROPAGATION IN VISCOELASTIC MEDIA Final Report**
George B. Thurston Aug. 1968 7 p refs
(Contract Nonr-2595(03))
(AD-676904) Avail: CFSTI CSCL 20/11

Studies have been made of wave propagation in both viscoelastic solids and viscoelastic liquids. Both theoretical and experimental wirk have been carried out and goals have been concerned with macroscopic wave propagation phenomena as well as interpretation of these phenomena on a microscopic basis. It has been sought to evaluate acoustic properties of materials from the viewpoint of viscoelasticity and to explore experiments for determining these properties as well as to evaluate the theoretical utility of such information. Wave propagation across interfaces, through layers, and transmission through plates have been considered. Work has been done on the propagation of flexural waves in metal plates and plastic plates. Shear wave propagation in viscoelastic liquids has been studied by utilizing optical birefringence associated with this propagation. Shear wave velocity and attenuation have been determined and reflected and interference effects studied. The influence of suspended macromolecules and solid particles on viscoelasticity and birefringence of liquids has been determined and has been related to sheer wave propagation effects both in theory and in measurements. Polymer additives which are important in drag reduction (Toms effect) have been studied by sheer wave techniques. Author (TAB)

**N69-13883#** Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).
**THE ADIABATIC THEORY OF THE MOTION OF CHARGED PARTICLES IN AN ELECTROMAGNETIC FIELD [THEORIE ADIABATIQUE DU MOUVEMENT DES PARTICULES CHARGEES DANS ON CHAMP ELECTROMAGNETIQUE]**
C. Laval and R. Pellat Jun. 1968 12 p refs In FRENCH; ENGLISH summary
(CERTS-NT-01-8) Avail: CFSTI

The essential results of the adiabatic theory are established: the guiding-center equations and the invariance of the magnetic moment and the longitudinal invariant are devised by using the asymptotic methods of the theory of nonlinear oscillations. ESRO

**N69-13890#** Naval Ship Research and Development Center, Annapolis, Md.
**MAXIMUM LUMINOUS EFFICIENCY CONTOUR CHARTS FOR COLORED MATERIALS**
G. K. C. Hardesty, R. L. Booker, and J. T. Mc Lane Oct. 1968 40 p refs
(AD-676725; ELECLAB-200/68) Avail: CFSTI CSCL 20/6

This note contains 17 principal figures. Each is a graphic portrayal of the maximum luminous efficiency of colored materials as illuminated by a specified source of light. Each figure consists of a family of isoefficiency contours, computer-plotted on the familiar 1931 International Commission on Illumination chromaticity diagram. Blackbody sources included in the 17 figures are 1600, 1800, 2000, 2200, 2360, 2854 (Illuminant A), 3000, and 3200 Kelvin. Equal energy and illuminants B, C, and D6500 are also included as are contour charts for several neon, mercury and other sources that have prominent line spectra. These charts are intended to be tutorial. They illustrate immutable constraints on the luminous efficiencies of even ideal colored materials. The relationships apply to light-reflecting as well as to light-transmitting materials. While the lower percentage contours of some of the figures are inherently imprecise quantitatively, all provide a basis for an approximate evaluation of an existing color filter (or colored material) in terms of an ideal filter (or colored material). Such an evaluation can reveal the possibility (or impracticality) of a significant improvement in luminous efficiency. Author (TAB)

**N69-13899#** Ion Physics Corp., Burlington, Mass.
**HIGH VOLTAGE BREAKDOWN STUDY. ADDENDUM: SOME FACTORS AND ASSOCIATED MECHANISMS INFLUENCING HIGH VOLTAGE INSULATION FAILURE IN VACUUM**
Alan Watson (Ph.D. Thesis—Tech. Hochschule Darmstadt) [1968] 176 p refs
(Contract DA-28-043-AMC-00394(E); ARPA Order 517)
(AD-676871; ECOM-00394-14-ADD) Avail: CFSTI CSCL 20/3

An experimental program has been initiated to study dc breakdown in vacuum up to 300 kV without reliance upon preconceived convictions of what are the mechanisms or participating factors. A range of possible factors previously reported to be influential in determining vacuum breakdown voltage was chosen with a view to studying their effects and interactions using the techniques of factorial experimental design. These methods are particularly useful in complex problems of applied physics in which many well understood fundamental physical processes operate

simultaneously but with varying degrees of significance. The nature of the vacuum breakdown mechanism presents just such a problem and the relative significance or total absence of several processes may be inferred from the results. A wide selection of physical monitoring techniques has also been employed to collect supplementary data from which some basic theoretical ideas of the possible breakdown mechanism were developed. These ideas have been analyzed in detail, leading to a mathematical theory of the breakdown mechanism. The theory not only explains the experimental data satisfactorily but also extends naturally into other operating regimes. Previously reported laws relating breakdown voltage and gap separation appropriate to cathode or anode dominated conditions have been confirmed and explained by the theory. New data on the influences of a weak magnetic field and of gas dissolved in the electrodes is presented and compares very satisfactorily with analytical predictions. A novel experimental technique was also developed for monitoring gas evolution instantaneously using the X-rays emitted as prebreakdown current accelerates through it. Author (TAB)

# 24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

**N69-12617** Rensselaer Polytechnic Inst., Troy, N. Y.
**A STUDY OF THE THERMAL VARIATION OF THE DEBYE TEMPERATURE OF ZINC**
Earl Franklin Skelton (Ph.D. Thesis) 1967 300 p
Avail: Univ. Microfilms: HC $13.50/Microfilm $3.85 Order No. 68-844

The mean square atomic displacement differences normal to and lying in, the basal plane of zinc have been measured from single crystal x-ray diffraction intensities over a thermal range from 50° to 600°K. A technique for analytically summing the contributions of thermal diffuse scattering to the measured x-ray intensities has been developed. This correction, along with a correction for small shifts in the diffraction peak due to lattice expansion, has been applied to the data. The atomic displacements are compared with existing theoretical and experimental values. The Debye temperature has been evaluated over the thermal range involved. Comparison is made with reported Debye temperatures as determined both theoretically and experimentally. Comparison is also made with Debye temperatures relating to other averages over the frequency distribution function. Dissert. Abstr.

**N69-12619** Yale Univ., New Haven, Conn.
**REMEASUREMENT OF THE LAMB SHIFT IN D, N EQUALS 2**
Barry Lee Cosens (Ph.D. Thesis) 1967 53 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-4846

The Lamb shift in the n = 2 level of deuterium has been measured by locating the crossing point of the levels $2^2S1/2(m_j = -1/2)$ and $2^2P1/2(m_j = +1/2)$ near 573 G. An atomic beam in the metastable $2^2S1/2$ state is prepared having a single hyperfine structure component of the $m_j = -1/2$ state. This beam then travels along the axis of a Helmholtz coil. This geometry eliminates Stark shifts due to motional electric fields. The transition is induced by a static electric field perpendicular to this magnetic field. Transitions utilizing two different hyperfine components are measured and yield two independent values of the Lamb shift. The weighted average of these two results disagrees with the original measurements of Lamb and with the most recent theoretical results. Dissert. Abstr.

**N69-12630** California Univ., Berkeley.
**THE EXCHANGE OF ENERGY BETWEEN TUNGSTEN AT HIGH TEMPERATURES AND GASES AT ROOM TEMPERATURE**
Mahn-Jick Lim (Ph.D. Thesis) 1967 100 p
Avail: Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 68-103

The exchanges of energy between a tungsten filament and room temperature neon, nitrogen, argon, krypton, oxygen, nitric oxide, nitrous oxide, mixtures of neon with krypton, and mixtures of argon with oxygen were studied over a wide range of filament temperatures and gas pressures. General trends in temperature dependences of the thermal accommodation coefficients are similar for the noble gases and for nitrogen. Variations for these gases reflect changes in the fraction of coverage of adsorbed surface impurities and in surface structures. All show maximum thermal accommodation coefficients near 2000° K. Dissert. Abstr.

**N69-12631** California Univ., Berkeley.
**MOLECULAR BEAM KINETICS (PARTS 1 AND 2)**
George Hsing Kwei (Ph.D. Thesis) 1967 360 p
Avail: Univ. Microfilms: HC $16.20/Microfilm $4.60 Order No. 68-98

Part I describes the crossed molecular beam studies that have been made of reactions of alkali atoms with alkyl iodides and with the mixed halogen molecules ICl and IBr. These two sets of reactions exhibit strikingly different behavior and are prototype examples of the rebound and stripping mechanisms. Part II explores theoretical and experimental aspects of the elastic scattering of chemically reactive molecules. Dissert. Abstr.

**N69-12632** Syracuse Univ., N. Y.
**THE ELASTIC SCATTERING OF LITHIUM IONS IN HELIUM AND HYDROGEN**
Floyd Joseph Zehr (Ph.D. Thesis) 1967 148 p
Avail: Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 67-12093

An experimental method for a measurement of the elastic scattering of Li + by He and $H_2$ is described. Energy discrimination detection of the scattered ion beam eliminates in this case the ambiguity involving the energy of the scattered particles as a double-valued function of the laboratory angle of scattering. The measurement of the scattered ions retaining more than certain energies as a function of scattering path length for a series of particle energies makes it possible to obtain a set of values for the atomic interaction potential as a function of the interatomic separation. The mathematical formulation relating to the experimental approach is presented. The development, design, arrangement, and function of the apparatus used to perform the experiment are described and discussed. Dissert. Abstr.

**N69-12634** Arizona Univ., Tucson.
**A TIME DEPENDENT VELOCITY DISTRIBUTION FUNCTION FOR LOW ENERGY ELECTRONS IN A GAS**
Norman Edward Levine (Ph.D. Thesis) 1967 120 p
Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 67-12200

Solutions of the time dependent, spatially independent Boltzmann equation for a system of low energy electrons immersed in a neutral gas are found. The physical configuration that is modeled is that of an initially homogeneous system of electrons in the steady state under the influence of an electric field. The relaxation of the initially non-Maxwellian velocity distribution function to the Maxwellian distribution function at the temperature of the gas is studied for the constant collision frequency case. The eigenfunctions and eigenvalues found for the case of the constant collision frequency are used, in a time independent perturbation

calculation, to find solutions for an almost constant collision frequency. The validity of the approximations that are used in the derivation of the distribution functions are analyzed. The results of numerical calculations of the time dependent electron distribution functions are presented for both the constant collision frequency case and the non-constant collison frequency case. Dissert. Abstr.

**N69-12650** Illinois Univ., Chicago.
**NUMERICAL TREATMENT OF PLANE SHOCK WAVES IN KINETIC THEORY OF GASES**
Eugene Yu Chang (Ph.D. Thesis) 1967 94 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-1721

A numerical method is developed to treat shock wave problems based on the Krook model equation in kinetic theory of gases. In this method, both the steady and non-steady problems are formulated as initial boundary value problems in which the boundary conditions are obtained from classical fluid dynamic thoery. This approach avoids certain singularities of the stationary shock problem which would have appeared in the formulation based on steady state equations. The method has been proved to be stable and convergent for all cases considered in this study and gives unique steady shock profiles regardless of the nature of the initial approximation. The steady shock profiles obtained by this method are in good agreement with previous results and with Navier–Stokes solution for an upstream Mach number of 1.5. For an upstream Mach number equal to 3.0, the present method produces unsymmetric shock profiles which deviate significantly from the Navier–Stokes results. Dissert. Abstr.

**N69-12654** Cornell Univ., Ithaca, N. Y.
**DOUBLE PION PHOTOPRODUCTION AND RADIATIVE PION NUCLEON SCATTERING**
Huey Wen Huang (Ph.D. Thesis) 1967 82 p
Avail: Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 68-879

The low energy total amplitude for double pion photoproduction is expressed in several parts by using the equal time current commutation relations and the hypothesis of the partial conservation of the axial vector current. The final state interaction theory is then applied to calculate the cross sections. In comparison with the static theory, there are additional terms in our method which play an important role in the angular distributions but not in the total cross sections. Our results are in fair agreement with the experiments on the total cross sections as well as the angular distributions. The dynamical and kinematical approximations involved are discussed in detail. An explicit amplitude for the low energy radiative pion nucleon scattering is derived in an isober model resembling that of Olsson and Yodh. Crossing relations and the time reversal invariance make it possible to exploit some results of the double pion photoproduction. Dissert. Abstr.

**N69-12655** Illinois Univ., Urbana.
**A NEW METHOD FOR COMPUTING INELASTIC MOLECULAR SCATTERING WITH APPLICATIONS TO ATOM-DIATOM AND DIATOM-DIATOM COLLISIONS**
Bernard Robert Johnson (Ph.D. Thesis) 1967 145 p
Avail: Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 68-1781

A new method for computing inelastic scattering problems in the many state coupled channel approximation (close coupling approximation) is developed. It is especially well suited for doing numerical calculations with a digital computer and for this purpose is superior to the usual method which involves solving a system of coupled differential equations. Using the formalism of this method, three problems are discussed in detail. The first is the collinear collision of a particle with a linear harmonic oscillator. The second problem considered is that of an atom colliding with a diatomic molecule. The third problem considered is the collision of two diatomic molecules. Dissert. Abstr.

**N69-12656** Michigan Univ., Ann Arbor.
**Te-125 MOESSBAUER EFFECT STUDY OF RADIATION EFFECTS AND MAGNETIC HYPERFINE INTERACTION IN TELLURIUM COMPOUNDS**
John Frederick Ullrich (Ph.D. Thesis) 1967 177 p
Avail: Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-17850

The purpose of the first part of this study was to experimentally determine the effects of neutron capture induced defects on Mössbauer hyperfine spectra in $Te^{125}$. Thermal neutron capture in $Te^{124}$ is used to simultaneously produce the Mössbauer isomeric state parent $Te^{125m}$ and to introduce the parent nucleus as a defect in the lattice. The displacement mechanism is the recoil of the nucleus due to the emission of 0.4 Mev of "prompt" gamma rays following the neutron capture. Since the Mössbauer hyperfine spectrum is sensitive to the immediate electronic environment of the emitting nucleus, the Mössbauer spectrum should provide information on characteristic defect environments. The purpose of the second part of this study was to experimentally investigate magnetic hyperfine spectra in magnetic compounds of tellurium. Dissert. Abstr.

**N69-12659** California Univ., Berkeley.
**THE NUCLEAR MAGNETIC MOMENT AND BETA DECAY ASYMMETRY OF ARGON-35**
Frank Paul Calaprice (Ph.D. Thesis) 1967 131 p
Avail: Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 68-5699

The nuclear magnetic dipole moment of argon-35 and the beta-decay asymmetry parameter for the mirror transition $^{35}Ar \rightarrow {}^{35}Cl$ (ground state) have been measured by an atomic beam technique. The angular distribution of electrons emitted from nuclei with polarization $P$ is proportional to $(1 + A\, v/c\, P \cos\theta)$, where $v$ is the electron velocity and $\theta$ is the angle between the electron velocity and the spin polarization axis. Argon-35 decays to three levels of chlorine-35, with the primary branch (83%) to the ground state. Because this transition involves no change in spin ($3/2 \rightarrow 3/2$), it is a mixture of both Fermi and Gamow–Teller radiations. The transitions to the two excited levels are pure G–T transitions. Since the asymmetries for pure G–T transitions are independent of the matrix elements, the ground-state asymmetry parameter can be determined by measuring the average asymmetry of the three transitions. Dissert. Abstr.

**N69-12692** Cornell Univ., Ithaca, N. Y.
**PROTON COMPTON EFFECT**
David Reuel Rust (Ph.D. Thesis) 1967 88 p
Avail: Univ. Microfilms: HC $4.60/Microfilm $3.00 Order No. 68-889

A review of previous experiments which investigate the proton Compton effect (elastic photon-photon scattering) is given and a few attempts at theoretical descriptions of the process are briefly described. Measurements of the differential cross section at 90° in the center-of-mass system for photon-proton scattering were made over a range of incident photon energies from 450 MeV to 1400 MeV. Spark chambers and counters were used to detect the outgoing proton and photon and the spark chamber photographs were analyzed using a special automatic scanning and measuring device. The results extend previous investigations to higher energies and show a remarkable dip in the cross section above the energy corresponding to the third nucleon isober. Dissert. Abstr.

**N69-12683** Brown Univ., Providence, R. I.
**ANALYTICITY PROPERTIES OF THE MESON-DEUTERON ELASTIC-SCATTERING AMPLITUDES AT LOW ENERGY**
Fujio Ando (Ph.D. Thesis) 1967 194 p
Avail: Univ. Microfilms: HC $8.80/Microfilm $3.00 Order No. 68-1432

The analyticity properties of the meson-deuteron elastic scattering amplitudes have been studied at low energy. The loosely bound nature of the deuteron results in small anomalous thresholds of the amplitudes in the t-channel and justifies the use of selected Feynman diagrams in the determination of general analyticity properties of the amplitudes. The impulse approximation, the binding corrections and the multiple-scattering terms are defined in terms of both triangle and box diagrams, and the dispersion relations with fixed s for these terms are derived by the method of analytic continuation with respect to the deuteron mass and with respect to s. It is found that the anomalous parts of the deuteron-baryon vertices play important roles in the derivation of the dispersion relations and that double scattering amplitudes have no complex singularities. Dissert. Abstr.

**N69-12696** Wisconsin Univ., Madison.
**ELASTIC SCATTERING OF POLARIZED DEUTRONS FROM ALUMINUM, SILICON, AND NICKEL**
Peter Schwandt (Ph.D. Thesis) 1967 185 p
Avail: Univ. Microfilms: HC $8.40/Microfilm $3.00 Order No. 67-12474

Polarization parameters have been measured for 7–11 MeV deuteron elastic scattering from $^{27}Al$, $^{28}Si$, and $^{60}Ni$ at laboratory angles between 30° and 135°. The vector polarization $iT_{11}$ and two tensor parameters $T_{20}$ and $T_{22}$ were obtained from measurements of the polarized-to-unpolarized cross-section ratio in the scattering of polarized and unpolarized deuteron beams obtained from the Wisconsin Tandem accelerator. The angular distributions of these polarization parameters show more or less pronounced oscillations about zero, with amplitudes generally increasing towards backward angles. In all cases the vector polarization was found to be larger than the tensor polarizations, with substantially larger effects observed for Al and Si than for Ni. An optical model analysis of the polarization and cross-section data was performed to obtain information about the various spin-dependent terms in the optical potential. Dissert. Abstr.

**N69-12697** Cornell Univ., Ithaca, N. Y.
**A QUARK MODEL OF THE BARYONS**
Joel Alan Shapiro (Ph.D. Thesis) 1967 58 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-892

The ever-growing spectrum of baryon states has made imperative an understanding of the relationships among particles of different spins. A phenomenological calculation of "coupling constants" from observed decay widths gives a convenient measure of the interaction. An analogy with electromagnetic decays of a charged harmonic oscillator is given, suggesting the potential power of an algebraic or group theoretic approach. A model is developed in which the baryons are the states of a three quark system bound by zero natural length springs. The spring constants and the masses are assumed independent of the type of quark, making the theory SU(6) invariant. The states are classified according to their symmetry under permutations, and the totally symmetric states are considered as possibilities for the known baryons. With one additional assumption it is possible to relate the decay widths of the non-strange baryons. Dissert. Abstr.

**N69-12700#** Institut Fiziki Vysokikh Energii, Serpukhov (USSR).
**THEORY OF A FIELD IN THE DISCRETE SPACE [TEORIYA POLYA V DISKRETNOM PROSTRANSTVE]**
A. N. Leznov 1968 5 p refs In RUSSIAN
(IFVE-STF-68-7-K) Avail: CFSTI

The general method to derive wave equations in the discrete space-time is formulated. Author (NSA)

**N69-12726** Princeton Univ., N. J. Palmer Physical Lab.
**USE OF A SMALL ON-LINE COMPUTER IN A WIRE SPARK CHAMBER EXPERIMENT**
R. E. Mischke, J. Metzger, P. F. Shepard, and T. J. Devlin 16 May 1968 35 p refs
(Contract AT(30-1)-2137)
(PPAR-3) Avail: CFSTI

The programming of a small computer used on-line with magnetostrictive wire spark chambers in an experiment to measure the neutron–proton elastic differential cross section for incident neutrons in the range 275 to 1500 MeV is described. NSA

**N69-12727#** Joint Inst. for Nuclear Research, Dubna (USSR).
**DIFFERENCE HYPERGEOMETRIC EQUATIONS AND THE RELATIVISTIC COULOMB PROBLEM**
M. Freeman et al 1968 15 p refs
(JINR-E2-3948) Avail: CFSTI

Finite-difference analogs of hypergeometric functions are introduced and the equations which they satisfy are found. The results obtained are used in finding the exact solution to the Coulomb problem, in the framework of the quasipotential approach. Author (NSA)

**N69-12729#** Institute of Nuclear Research, Krakow (Poland).
**NEUTRON INVESTIGATION OF THE SPIN WAVE DISPERSION RELATION IN alpha-CO**
Zivan Dimitrijevic et al May 1968 27 p refs
(INP-610) Avail: CFSTI

The inelastic magnon scattering of monoenergetic neutrons on a single crystal of hexagonal cobalt was investigated. A neutron crystal spectrometer was used, and the neutron diffraction technique applied. For several missetting angles, the total widths of scattered neutron cones which corresponded to scattering surfaces at a reciprocal lattice vector were measured. The scanning was performed along two directions (horizontal and vertical) for $\Delta\Theta \epsilon [3.5°, 36°]$, hence it was possible to determine the acoustic magnon dispersion relations. The results are compared with Low's theoretical predictions based on the Heisenberg—Dirac Hamiltonian. For the small wave vectors, no noticeable discrepancy between D constants, which determine the dispersion relation of quadratic type, was observed. Author (NSA)

**N69-12740** Princeton Univ., N. J.
**SCATTERING CROSS-SECTIONS AND THE INTERMOLECULAR POTENTIAL FOR ARGON**
Bernard Baratz (Ph.D. Thesis) 1967 141 p
Avail: Univ. Microfilms: HC $8.80/Microfilm $3.00 Order No. 68-2458

The total collision cross-section for argon atoms scattered off argon atoms was determined over a wide range of relative velocities. A study of the velocity variation of these cross-sections enabled characterization of the intermolecular potential of argon. Measurements were made of the intensity reduction of one molecular beam (primary beam) when it was scattered along part

of its path by another molecular beam (scattering beam). The low velocity measurements were in accord with the theory of Massey and Mohr for an inverse-six potential. However, undulatory deviations from this theory as predicted by Bernstein were observed. Quantum calculations indicate that the cross-sections obtained are consistent with both Kihara and Lennard Jones models for the intermolecular potential. In addition, the long range attractive portion of the intermolecular potential is in reasonable agreement with current theoretical predictions. Dissert. Abstr.

**N69-12762#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics.
**INVESTIGATION OF THE $Be^9$ PLUS T REACTION**
Kim Syn Nam and G. M. Osetinskii 1968 28 p refs In RUSSIAN
(JINR-P15-3965) Avail: CFSTI

The differential cross sections of the $^9Be(t,\alpha_0)^8Li$, $^9Be(t,\alpha_1)^8Li^*$, $^9Be(t,d_0)^{10}B$ reactions were measured using a thin Be target at 90 and 70° in the energy range 520 to 1700 keV. The angular distributions of both the groups of $\alpha$ particles were measured for a number of triton energies. The results show that in the range of the compound nucleus $^{12}B$ excitation energy from 13.3 to 14.2 keV, sufficiently narrow energy levels are not observed. On the basis of the angular distributions the total cross sections of the yield of the mentioned $\alpha$-particle groups of the reaction are obtained. Author (NSA)

**N69-12765** Connecticut Univ., Storrs.
**HIGHLY EXCITED STATES OF MANY ELECTRON ATOMS**
James Barr Carroll (Ph.D. Thesis) 1967 64 p
Avail: Univ. Microfilms: HC $3.60/Microfilm $3.00 Order No. 68-1327

This thesis is concerned with the quantum mechanical description of autoionizing states of many electron atoms. The major emphasis is on the calculational aspects of obtaining one-electron wave functions by means of a selfconsistent field procedure. The decay of the autoionizing, or metastable, state is described within the formalism of time dependent perturbation theory. A procedure is developed by which the iterative solutions of Schrodinger's equation (in the Hartree or Hartree–Fock scheme of approximation) are constrained such that they always converge to a bound state (normalizable) wave function. Time dependent perturbation theory is used to describe the time development of the initial metastable state. By means of projection operators and the recognition of the role played by different time scales in the decay process, a more general result is obtained for the decay of the metastable state. Dissert. Abstr.

**N69-12771#** Oak Ridge National Lab., Tenn. Physics Div.
**COULOMB EXCITATIONS OF ROTATIONS AND VIBRATIONS IN EVEN-EVEN RARE EARTH NUCLEI**
Royce Orlando Sayer (Ph.D. Thesis—Tenn. Univ.) Sep. 1968 235 p refs
(Contract W-7405-eng-26)
(ORNL-TM-2211) Avail: CFSTI

The Coulomb excitation process was utilized to study rotational and vibrational states in the nuclei $^{152}Sm$, $^{166}Er$, and $^{172,174,176}Yb$. The objectives of this investigation were to accurately measure: reduced transition probabilities within the ground-state rotational bands, reduced transition probabilities for excitation of vibrational states; and branching ratios for transitions from vibrational states to members of the ground state bands. These accurate measurements were needed to provide stringent tests for the nuclear models now in vogue for strongly deformed nuclei. Rotational states were primarily studied by means of multiple Coulomb excitation with 42 to 52 MeV $^{16}O$ ions. Both (Ge(Li)) and NaI detectors were used to observe the de-excitation $\gamma$ rays in coincidence with projectiles scattered into an annular detector from thick targets. Author (NSA)

**N69-12772** California Univ., Berkeley.
**A PHYSICAL INTERPRETATION OF STATIC MODEL PARAMETERS**
Francis Landis Markley, Jr. (Ph.D. Thesis) 1967 58 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-111

We show that an approximation to the static crossing matrix leads to a soluble model for the $p_{11}$ and $p_{33}$ $\pi N$ scattering amplitudes in which the parameters are related to forces due to particle exchanges in the t-channel. Reasonable values of these forces give the nucleon bound state and the $\Delta$ resonance in good agreement with experiment. Dissert. Abstr.

**N69-12774** Princeton Univ., N. J.
**ENERGY DEPENDENCE OF THE FORM FACTOR IN POSITIVE KAON-e3 DECAY**
Richard Larry Imlay (Ph.D. Thesis) 1967 71 p
Avail: Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 68-2488

The decay $K^+ \rightarrow e^+ + \pi^0 + \nu$ has been investigated in a spark chamber and counter experiment at the Princeton-Pennsylvania Accelerator. The $K^+$ mesons were stopped in a block of beryllium. A threshold gas Cerenkov counter was employed to select the positronic decay mode and the positron momentum was obtained with a series of thin plate spark chambers located in a magnetic field between the $K^+$ stopping region and the Cerenkov counter. The directions of the gamma rays from the $\pi^0$ decay were measured with a pair of lead plate spark chambers. A Dalitz plot of 1393 $K^+_{e3}$ events agrees well with vector coupling. The $\pi^0$ energy spectrum was investigated to determine the energy dependence of the strong interaction form factor $f_+(q^2)$ where $q^2$ is the square of the four momentum transferred to the leptons and equals $M_k^2 + M_\pi^2 - 2M_kE_\pi$ for $K^+$ decays at rest. Dissert. Abstr.

**N69-12775** Rensselaer Polytechnic Inst., Troy, N. Y.
**FAST PHOTONEUTRON SPECTRA DUE TO 55–85 MeV PHOTONS**
Narinder N. Kaushal (Ph.D. Thesis) 1967 211 p
Avail: Univ. Microfilms: HC $9.70/Microfilm $3.00 Order No. 68-831

Energy spectra of fast photoneutrons from eighteen elements (Li, Be, B, C, N, O, Al, S, Fe, Cu, An, In, Sn, Ta, Tl, Pb, Bi, and U) were measured at 67 1/2°, using thin target bremsstrahlung from the Rensselaer linac. The neutron detection system utilized a 100-meter flight path with overall time resolution of 0.4 nanoseconds per meter. Measurements of the spectra from each target at bremsstrahlung energies of both 55 MeV and 85 MeV permitted extraction of a neutron spectrum in each case which is effectively due to photons between 55 MeV and 85 MeV. Cobalt foils were used as relative photon monitors. Absolute normalization of the spectra was effected by comparison with the experimentally measured photoneutron spectrum of deuterium. The systematic dependence of the neutron production cross sections on target Z was compared to the predictions of the modified quasi-deuteron model taking account of optical attenuation. The effect of secondary neutron production was estimated by approximate Monte Carlo calculations. It is found that the results are in agreement with the quasi-deuteron model. Dissert. Abstr.

**N69-12778*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**EXCITED STATES OF BARIUM 136 AND BARIUM 134**
Glenn M. Julian and Theodore E. Fessler Washington Dec. 1968 26 p refs
(NASA-TN-D-4933) Avail: CFSTI CSCL 20H

Sources of 9.87-minute lanthanum 136 and 6.82-minute lanthanum 134 were made by bombarding enriched barium 136 and barium 134 with 10-MeV protons. A 20-cubic-centimeter lithium-drifted germanium detector was used to observe the gamma rays emitted by lanthanum 136 and lanthanum 134. The energies and relative intensities of these gamma rays were measured. The results suggest the existence of excited states of barium 136 at 818.5, 1578.9, 2080.2, 2128.5, 2141.0, and 2315.6 keV, and excited states of barium 134 at 604.7, 1168.2, 2159.7, 2336.4, 2489.3, 2565.1, 2599.9, and 2693.3 keV. Author

**N69-12780** North Carolina Univ., Chapel Hill.
**QUANTIZATION OF RELATIVISTIC ACTION-AT-A-DISTANCE THEORIES**
James Horton Cooke (Ph.D. Thesis) 1967 67 p
Avail: Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 68-2169

Relativistic action-at-a-distance mechanics constitutes a definite alternative to classical field theory. It has a simple formulation, and is free of the self-energy divergence. Feynman's path integral technique can furnish a definition for the S-matrix, but there is no proof for its unitarity. On the other hand, conventional quantum electrodynamics can be put into a path integral form for comparison with the proposed S-matrix theory. This procedure requires a wavefunction representation $\psi(A_\mu)$ for the electromagnetic field which conforms to the requirements of Lorentz and gauge invariance. There is a way to represent the methods of Gupta and Bleuler, even though the wavefunctions are not in the usual $L^2$ Hilbert space. We have not proved the unitarity of the proposed theory, but there is no difficulty in defining a conserved electrical current. Also, the theory describes, in a natural way, the creation and interaction of particles of differing masses. Dissert. Abstr.

**N69-12782#** Institute of Nuclear Research, Krakow (Poland).
**THREE LECTURES ON PHENOMENOLOGY OF MULTIPARTICLE PROCESSES AT HIGH ENERGY**
A. Bialas Apr. 1968 22 p refs
(INP-599) Avail: CFSTI

The fundamental ideas of the recent theoretical work on multiparticle production processes are reviewed. The first lecture deals with the kinematics, the uncorrelated jet model, the simple peripheral model, and the multiperipheral model. A particular example of the application of the multiperipheral model to the study of three-body final states produced in high-energy collisions of hadrons is considered in the second lecture. Some work on multi-particle processes done recently by experimental groups in Cracow and Warsaw is reviewed in the third lecture. NSA

**N69-12785#** Gosudarstvennyi Komitet Po Ispolzovaniyu Atomnoi Energii, Obninsk (USSR).
**A STUDY OF THE REACTION NEGATIVE PION p YIELDS DELTA RESONANCE (1236) NEGATIVE PION NEGATIVE PION WITH THE MOMENTUM OF THE NEGATIVE PION AT 3.25 GeV/c**
I. A. Vetlitskii et al 1968 19 p In RUSSIAN
(ITEF-590) Avail: CFSTI

Eleven hundred and eight events of the reaction $\pi^- p \rightarrow \Delta^+(1236)\,\pi^-\pi^-$ were selected and analyzed on 160,000 photographs from the 55 cm hydrogen bubble chamber exposed in the $\pi^-$ meson beam at 3.25 GeV/c. By means of the modified Chew-Low formula, the values $\sigma_{\pi\pi}(T = 2)$ were obtained for the five regions of the effective masses of two $\pi^-$ mesons. The scattering length was obtained to be $|a_2| = (1.7 \pm 0.8) \cdot 10^{-14}$ cm. Assuming the purely elastic $\pi^-\pi^-$ interaction, phase analysis was performed aiming to determine the phase shifts $\delta_{20}$ and $\delta_{22}$. In the $\pi^-\pi^-$ spectrum there is an enhancement in the region of 800–850 MeV, after the events in the $\rho^0$ band have been excluded. Additional investigations are necessary to confirm this bump. Author (NSA)

**N69-12787#** Duke Univ., Durham, N. C.
**PROGRESS REPORT [ON HIGH-ENERGY PHYSICS], JULY 1, 1967–JUNE 30, 1968**
5 Aug. 1968 7 p
(Contract AT(40-1)-3065)
(ORO-3065-16) Avail: CFSTI

The development of RIPPLE, a semiautomatic measuring device for analyzing bubble chamber particle tracks, is described. Also, the high-energy physics research work at Duke is briefly outlined. NSA

**N69-12791** Virginia Univ., Charlottesville.
**STUDY OF CHARGE SPECTRA OF KRYPTON AS A FUNCTION OF X-RAY ENERGY**
Seun Kwon Kahng (Ph.D. Thesis) 1967 71 p
Avail: Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 67-17655

For the study of charge spectra of Krypton resulting from an inner shell vacancy as a function of X-ray energy, a time of flight spectrometer and a pulsed X-ray tube were built. The relative charge spectra of Krypton ionized by X-rays from a tungsten target were measured as a function of the voltage across the X-ray tube with the time of flight spectrometer. The voltage was varied in 1 kv steps from 3 kv to 20 kv and the X-ray spectrum was unfiltered. The total yields at each voltage were normalized to the total number of photons at 20 kv per current. The total normalized yield decreased as a function of voltage and the average charge increased from 2.99 at 3 kv to 4.64 at 20 kv. Relative yields of the individual ionic species from +1 to +8 were also determined. Dissert. Abstr.

**N69-12809** California Univ., Berkeley.
**HYPERFINE STRUCTURE AND MAGNETIC MOMENT OF Ag-110m AND SPIN OF Tm-163**
Stephen Gordon Schmelling (Ph.D. Thesis) 1967 84 p
Avail: Univ. Microfilms: HC $4.40/Microfilm $3.00 Order No. 68-152

The atomic-beam magnetic-resonance technique was used to measure the free-atom ground state hyperfine-structure separation $\Delta\nu$, the nuclear magnetic moment $\mu_I$, and the hyperfine-structure anomaly $^{109}\Delta^{110m}$ of 260-day $Ag^{110m}$ ($I = 6$). The magnetic moment $\mu_I$ was obtained independently of $\Delta\nu$ by observing a $\Delta F = \pm 1$ doublet at its field-independent point. The results are $\Delta\nu(Ag^{110m}) = +30313.756(4)$ MHz, $\mu_I(Ag^{110m})$ (uncorr) $= +3.587(4)$ nm, and $^{109}\Delta^{110m} = -2.47(12)\%$. A short experiment was also done to measure the nuclear spin of 108-min $Tm^{163}$. The result of this experiment is $I = 1/2$ for $Tm^{163}$. Dissert. Abstr.

**N69-12816** Wisconsin Univ., Madison.
**COLLISIONAL TRANSFER CONTRIBUTIONS IN THE QUANTUM THEORY OF TRANSPORT PHENOMENA**
R. Soesanto Imam-Rahajoe (Ph.D. Thesis) 1967 203 p
Avail: Univ. Microfilms: HC $9.25/Microfilm $3.00 Order No. 67-12130

The quantum mechanical BBGKY equations are solved in terms of the phase space transformation functions. Introducing the molecular chaos approximation, the pair distribution function is obtained. In the binary collision approximation this leads to a generalized Boltzmann equation, in which the collisional transfer contribution is included. This equation is solved by the method of Chapman and Enskog, and expressions for the transport properties are obtained. The classical limit of the expressions are also derived. The heat flux is found to contain a contribution which is proportional to the gradient of the density. The significance of this term is discussed. Dissert. Abstr.

**N69-12817#** Kansas Univ., Lawrence.
**EXPERIMENTAL AND THEORETICAL STUDIES OF MAGNETIC RESONANCE AND RELAXATION Progress Report, 1 Sep. 1967–15 Aug. 1968**
15 Aug. 1968 22 p refs
(Contract AT(11-1)-1488)
(COO-1488-13) Avail: CFSTI

Progress is reported on experimental projects in nuclear and electronic spin wave excitation and improvement of fast pulse techniques. Theoretical work on nuclear spin-wave relaxation, relation between spin–lattice relaxation and line width in the Orbach process, and calculation of magnetic resonance line width is reported. Minimum relaxation is found at a given wave vector which increases linearly with temperature. A broad band helix is being incorporated into the spectrometer for future high-power fast-pulse work employing a 1-kW traveling-wave tube currently on order. Theoretical treatment of nuclear spin wave relaxation rates shows them to be considerably less than expected on the basis of second moment of the Suhl–Nakamura interaction. The line width of isolated paramagnetic ions has been derived for spin lattice interaction via the Orbach process. Observed discrepancy between line width and spin lattice relaxation rate can be accounted for by this calculation only if there is phonon bottlenecking. Author (NSA)

**N69-12834** Cornell Univ., Ithaca, N. Y.
**UNITARITY-ANALYTICITY EQUATIONS FOR ELASTIC PION-NUCLEON SCATTERING: A NUMERICAL SOLUTION**
John Raymond Boccio (Ph.D. Thesis) 1967 79 p
Avail: Univ. Microfilms: HC $4.20/Microfilm $3.00 Order No. 68-866

The problem of elastic pion-nucleon scattering is considered. Using the elastic unitarity approximation together with Mandelstam analyticity and the crossing principle, we have devised an approximation scheme which enabled us to derive a set of four coupled linear integral equations for the imaginary parts of the u-channel absorptive parts. We then included meromorphy in the J-plane or Regge asymptotic behavior. We carried out a numerical solution of these equations. The results were very encouraging in the sense that we were able to produce output trajectories which have some interesting properties, i.e., we were able to generate trajectory functions which easily rise to values of Re $\alpha_1(u) \approx 3/2$ and possess a shape which resembles the conventionally assumed form. Dissert. Abstr.

**N69-12835** California Univ., San Diego.
**THE POINT FORM OF RELATIVISTIC DYNAMICS**
Herbert Joseph Bernstein (Ph.D. Thesis) 1967 103 p
Avail: Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 68-2629

The point form of relativistic Hamiltonian dynamics suggested by Dirac is developed and studied for two-particle elastic interactions. A class of potentials is found for which the solutions of the point form dynamics can be readily obtained, both for bound states and scattering states. For these potentials the theory is shown to be equivalent to that of the standard instant form of dynamics. Dissert. Abstr.

**N69-12840*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
**ELASTIC SCATTERING OF 21-MeV PROTONS FROM NITROGEN 14, OXYGEN 16, ARGON 40, NICKEL 58, AND TIN 116**
Norton Baron, Regis F. Leonard, and David A. Lind (Colo. Univ., Boulder) Washington Dec. 1968 26 p refs
(NASA-TN-D-4932) Avail: CFSTI CSCL 20H

Differential cross section angular distributions were measured for 21 MeV incident protons elastically scattered from $^{14}N$, $^{16}O$, $^{40}A$, $^{58}Ni$, and $^{116}Sn$. An optical model analysis was performed on these data and on previously measured elastic polarizations of 21 MeV incident protons scattered from the same nuclei. The optical potential used in this analysis included a real central term, a surface absorption term, and a real spin orbit term. Good fits to both the cross sections and polarizations for all nuclei except $^{16}O$ were obtained by allowing the nine parameters of the optical potential to vary from nucleus to nucleus. Author

**N69-12843** Minnesota Univ., Minneapolis.
**MICROWAVE CONDUCTIVITY OF SILICON AND GERMANIUM**
John David Holm (Ph.D. Thesis) 1967 119 p
Avail: Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 68-1535

The electrical conductivity of a semiconductor at microwave frequencies differs from the dc conductivity because of the influence of the inertia of the charge carriers. Inertial effects become apparent at frequencies $\omega$ approaching $1/\langle\tau\rangle$ where $\langle\tau\rangle$ is the average relaxation time of the momenta of the carriers. At such frequencies, the microwave conductivity is complex, i.e., the carriers contribute a component of current out of phase with the electric field as well as an in phase component. As the product of the radian frequency $\omega$ times $\langle\tau\rangle$ increases, the in-phase component of current decreases and the out of phase component increases until $\omega\langle\tau\rangle \cong 1$. The in phase component is proportional to the real part of the complex microwave conductivity. The out of phase component is proportional to the imaginary part and subtracts from the displacement current associated with polarization of the atomic lattice. Dissert. Abstr.

**N69-12856** Illinois Univ., Urbana.
**NORMALIZATION OF BETHE-SALPETER AMPLITUDES**
Amarjit Harnamsingh Singh (Ph.D. Thesis) 1967 75 p
Avail: Univ. Microfilms: HC $4.00/Microfilm $3.00 Order No. 68-1856

Two new derivations of the normalization condition for Bethe-Salpeter (bound state) amplitudes are presented. The first derivation is based on charge conservation. The normalization condition obtained is independent of the total charge of the system and, in principle, could be applied to a neutral system if we could regard a neutral system as being the limiting case of a charged one. The second derivation is based on energy-momentum conservation. The final result is precisely of the same form as the one obtained from charge conservation. We believe this to be the first derivation based on the expectation value of a conserved quantity which is applicable to all possible two-body systems, including neutral ones. Our results agree completely with the recent work of other authors who have used methods different from ours. Normalization of Wick's solution is presented as an illustration of the application of our normalization condition. Dissert. Abstr.

**N69-12858#** Illinois Univ., Urbana.
**STATUS OF EXPERIMENTAL SEARCHES FOR CP VIOLATION IN OTHER THAN NEUTRAL K-DECAYS**
A. Wattenberg Jul. 1968 11 p refs Presented at the Summer Inst. for Theoret. Phys., Boulder, Colo., Jul. 1968
(Contract AT(11-1)-1195)
(COO-1195-138) Avail: CFSTI

A review is given of the experimental searches for CP or T violation in interactions other than $K^0$ decays, with emphasis on the $\tau$ decays. Previous works as well as experiments planned or in progress are tabulated. NSA

N69-12887 Michigan State Univ., East Lansing.
**A STUDY OF CORIOLIS-TYPE RESONANCE IN HYDROGEN SULFIDE**
Lewis Emil Snyder (Ph.D. Thesis) 1967 185 p
Avail: Univ. Microfilms: HC $8.40/Microfilm $3.00 Order No. 68-4217

The second-order quantum mechanical molecular Hamiltonian expression for the nonlinear XYX asymmetric molecule is modified to include Coriolis-type perturbations between pairs of mutually interacting infrared absorption bands. As a result, expressions are found for the coupled Wang energy matrices which include the centrifugal stretching terms and the perturbation coefficients. The modified Hamiltonian is used to analyze simultaneously the (110) and (011) absorption bands of $H_2S$ near 3800 $cm^{-1}$. Ground state combination differences from these two bands together with those from the (210) and (111) bands (near 6300 $cm^{-1}$) were combined with seven microwave lines to obtain values for the ground state parameters A, B, C, four taus, and $H_K$ for $H^{32}S$. Using these ground state values, the (110) and (011) bands of $H_2{}^{32}S$ were reanalyzed to obtain final values for the upper state parameters of each band and the parameters coupling the two bands. Dissert. Abstr.

N69-12890# TRW Systems Group, Redondo Beach, Calif.
**MODIFICATION OF SAND 2, DECEMBER 1967–JUNE 1968**
S. Berg Aug. 1968 98 p refs Prepared for Battelle-Northwest
(Contract AT(45-1)-1830)
(BNWL-855) Avail: CFSTI

A modified version of the SAND II code for determining neutron flux spectra from multiple foil activation measurements is described. The program was altered primarily to retard the generation of spurious structure in neutron differential spectra, while allowing real structure to be indicated. NSA

N69-12905# California Univ., Santa Barbara. Dept. of Physics.
**LIQUID HYDROGEN AND DEUTERIUM DIFFERENTIAL CHERENKOV COUNTERS**
David O. Caldwell, Virgil B. Elings, William P. Hesse, Roland J. Morrison, David S. Ayres (Calif. Univ., Berkeley) et al Jul. 1968 15 p Presented at the Intern. Symp. on Nucl. Electron., Versailles, France
(Contract AT(11-1)-34)
(UCSB-34-P-135-7; CONF-680906-3) Avail: CFSTI

A liquid hydrogen differential Cherenkov counter was developed to detect 0.3 GeV/c ($\beta = 0.92$) pions for comparing $\pi^+$ and $\pi^-$ lifetimes in a check of CPT invariance. This type of counter, previously reported, has now been improved considerably so that it gives no empty-counter counts, remains clean with no window fogging, and has a very stable index of refraction. Liquid deuterium has also been used successfully as the Cherenkov medium, and a large counter (7-inch diameter) has been made. Both the large and small (4-inch diameter) counters have cleanly separated pions and muons of the same momentum, with a peak-to-valley ratio of about $10^4$:1 for particles traversing the counter. Author (NSA)

N69-12910 Illinois Univ., Urbana.
**THE REACTION NEGATIVE KAON d YIELDS NEUTRAL KAON ANTI-PARTICLE nn, FROM THRESHOLD TO 300 MeV/c. POSITIVE KAON p ELASTIC SCATTERING: 60–280 MeV/c**
Robert Maurice Lansford (Ph.D. Thesis) 1967 101 p
Avail: Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 68-1796

The cross section for the reaction $K^-d \rightarrow \bar{K}^0nn$ has been measured for the laboratory momentum interval from threshold (96.7) to 300 MeV/c. The cross section is found to rise quickly above threshold to around 6 mb at 150 MeV/c, then decrease slowly from 150 to 300 MeV/c. The experimental values are found to be consistently lower (about 20%) than the recent values calculated by Hetherington and Shick using Faddeev techniques. An experiment has been performed using the Berkeley 15 inch Hydrogen bubble chamber to measure the low energy $K^+p$ elastic scattering cross section. Although the differential cross section is generally lower than those obtained by Stubbs, the experiments are consistent to within the quoted experimental errors. Dissert. Abstr.

N69-12917 Brown Univ., Providence, R. I.
**SOLUTIONS OF A MODEL FIELD THEORETICAL EQUATION FOR THE NEUTRON-PROTON MASS DIFFERENCE**
Thomas Korff Gaisser (Ph.D. Thesis) 1967 93 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-1455

The neutron-proton mass difference is calculated to order $e^2$ within the framework of a field theoretical model. The model is equivalent to a linear integral equation for the difference between the neutron and proton self-energy functions. The inhomogeneous term in this equation is the elastic contribution to the difference between the neutron and proton mass operators; calculation of this elastic contribution alone gives the wrong sign for the mass difference. A method is developed to solve the integral equation numerically. When certain assumptions are made for the spectral representations of the self-energy functions, both elastic and exact, the correct sign is found for the neutron-proton mass difference. The calculation provides a qualitative insight into a mechanism of electromagnetic origin which may be responsible for the observed n–p mass difference. Dissert. Abstr.

N69-12922 Washington State Univ., Pullman.
**ION BURIAL AND THERMAL REEMISSION AT NICKEL SURFACES**
John Francis Truhlar (Ph.D. Thesis) 1967 67 p
Avail: Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 68-723

The trapping and thermal reemission of 100–300 eV $Ar^+$ and $Kr^+$ ions at a polycrystalline nickel target have been studied. For $Ar^+$ and $Kr^+$ the trapping probabilities are respectively 0.020 and 0.015 at 100 eV and 0.46 and 0.33 at 300 eV. Thermal reemission after trapping reveals peaks in the reemission spectrum with corresponding activation energies of 1.18 eV, 1.36 eV, 1.53 eV, 1.72 eV, 1.89 eV, and 2.20 eV. The lowest three energies are believed to be respectively correlated with interstitial migration, vacancy formation, and vacancy migration near the surface. The highest energy may be due to surface recrystallization from dislocations produced by the ion bombardment. The intermediate energies probably correspond to the motion of nickel surface atoms along the ridges of facets formed during the bombardment. The measured activation energies for the release of gas atoms correspond to activation energies which are determined by others for the removal of defects resulting from radiation damage or cold working of nickel. Dissert. Abstr.

N69-12923# Rochester Univ., N. Y. Dept. of Physics and Astronomy.
**QUASI 2-BODY REACTIONS IN 13-GeV/c K PLUS p INTERACTIONS**
J. C. Berlinghieri, M. S. Farber, T. Ferbel, B. E. Forman, A. C. Mellisinos et al 30 Jul. 1968 17 p refs Presented at the 14th Intern. Conf. on High Energy Phys., Vienna
(Contract AT(30-1)-875)
(UR-875-251; CONF-680809-22) Avail: CFSTI

The final states $pK^* + (890)$, $K^0N^{*++}(1236)$, $K^{*0}N^{*++}(1236$ AND $PK\pi\pi$ (1300) as produced in 12.7 GeV/c $K^+p$ interactions

were studied. The density matrix elements and t-distributions were obtained and were compared to theoretical models. A new analysis of the $K\pi\pi$ (1300) confirms the 1+ spin parity assignment for this mass region and indicates that if the $K\pi\pi$ (1300) is a member of an octet then it belongs to the same octet as the $A_1$ ($J^{PC} = 1++$).
Author (NSA)

**N69-12933*#** Reilly Translations, Los Angeles, Calif.
**ON THE ANALYTICAL EXPRESSION OF THE IONIZATION CROSS SECTION FOR ATOM-ATOM COLLISIONS AND ON THE ION-ELECTRON RECOMBINATION IN DENSE NEUTRAL GASES**
Hans-Werner Drawin 1968 12 p refs Transl. into ENGLISH from Z. Physik (West Berlin), v. 211, 1968 p 404-417 Prepared for JPL
(Contract NAS7-100)
(NASA-CR-97882) Avail: CFSTI CSCL 20H

Thomson's classical theory for the calculation of ionization cross sections in electron-atom encounters is applied for calculating the ionization cross section for atom-atom collisions. A very simple formula is obtained permitting a rapid calculation of the total ionization cross sections as a function of the kinetic energy and the mass of the ionizing atom, and of the binding energy and the number of equivalent electrons in the electronic shell to be ionized. The formula is in good agreement with quantum mechanical calculations and with experimental results. It can be applied to ionization from ground and from excited states. From this formula one obtains an expression for the rate coefficient for ionization in the center-of-mass system of the colliding particles. Then, the method of detailed balancing is applied to calculate the rate coefficient for ion-electron three-body collisional recombination with a neutral atom acting as the third body. This latter formula is applicable to recombination into the ground and into excited states.
Author

**N69-12936** Stanford Univ., Calif.
**AN EXPERIMENTAL INVESTIGATION OF FISSION FRAGMENT ELECTRONIC CHARGE LOSS**
Harold Jacob Linnerud (Ph.D. Thesis) 1967 95 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 67-17458

A system was designed to measure the effective electronic charge of fission fragments. The main structural component was a six-inch diameter aluminum tube, which was positioned in the thermal column of the Stanford Pool Reactor, and evacuated to $\approx 1 \times 10^{-6}$ mm. Hg. for measurements. The fragment emitter was a 10 mil stainless steel disc with a 2.31 mg./cm.$^2$ coating of $UO_2$ (93% enriched). Fragments emitted in a small solid angle along the forward direction deposited their charge on a collector plate at the other end of the tube. Emitter-collector separation was 20 inches. A grid system was designed to control primary and secondary electron effects. The rate of charge deposition was determined with a sensitive DC electrometer. Permanent magnets were affixed to the rear of the emitter plate and background measurements were made by using external electromagnets to rotate the emitter by 180°.
Dissert. Abstr.

**N69-12943#** California Univ., Livermore. Lawrence Radiation Lab.
**ON THE ANOMALOUS DIFFRACTION OF X RAYS THROUGH PERFECT CRYSTALS**
R. C. Schroeder 25 Jun. 1968 11 p refs
(Contract W-7405-ENG-48)
(UCRL-50439-Pt-2) Avail: CFSTI

The theory of anomalous transmission is developed further by presenting von Laue's macroscopic derivation of the dispersion equations for diffraction in a crystal. The equation for the dispersion surface is developed and its relationship to the Ewald sphere is discussed.
Author (NSA)

**N69-12955#** Institut Fiziki Vysokikh Energii, Serpukhov (USSR).
**CONCERNING SEARCHES FOR HEAVY LEPTONS BY THE OBSERVATION OF THEIR FREE PATHS**
V. V. Makeev and V. N. Folomeshkin 1968 14 p refs In RUSSIAN
(IFVE-SEF/STF-68-6-K) Avail: CFSTI

The spectra dN/dE of the heavy leptons being produced in the reactions $\nu n \rightarrow lp$, the path length distribution dN/dx of the heavy leptons, the number of heavy leptons N(x) having the path more than x have been computed. The computations were made for the CERN neutrino spectrum, for the spectra of neutrinos expected at the IHEP accelerator and for the various masses of the heavy leptons. The results are represented as plots.
Author (NSA)

**N69-12956#** Istituto Superiori di Sanita, Rome (Italy). Lab. di Fisica.
**HIGH-ENERGY COLLISIONS AND THE SPIN DISTRIBUTION OF HADRON STATES**
G. Matthiae 5 Jul. 1968 15 p refs
(ISS-68/21) Avail: CFSTI

The existence, at high energy, of many overlapping resonant states is assumed. From the empirical spin distribution of hadron states the observed shape of diffraction peak is predicted correctly.
Author

**N69-12961** Illinois Univ., Urbana.
**VIOLATION OF CP INVARIANCE IN WEAK INTERACTIONS**
Lowell James Swank (Ph.D. Thesis) 1967 77 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-1865

We present here a new theory of non-leptonic weak interactions based on neutral F-spin currents of the $SU_3$ current algebra. Both CP conserving and CP violating non-leptonic processes are generated by the same primary interaction. This interaction is used to calculate the s-wave amplitudes of hyperon non-leptonic decays, the $K_1^0 \rightarrow 2\pi$ decay rate and the decay rate of the CP violating process $K_1^0 \rightarrow 2\pi$. The neutron electric dipole moment, which depends on the violation of space-reflection invariance and of time-reversal invariance, is also calculated. It is found that in this theory the selection rule $\Delta S \neq \pm 2$ has as a consequence the Gell-Mann-Okubo mass formulas and the F/D ratios for both the axial vector current and the mesonbaryon strong interactions.
Dissert. Abstr.

**N69-12963** California Univ., Berkeley.
**STUDY OF Y RESONANT AMPLITUDES BETWEEN 1660 AND 1900 MeV IN THE REACTION NEGATIVE KAON PLUS NEUTRON YIELDS LAMBDA HYPERON PLUS NEGATIVE PION**
Wesley Mitchell Smart (Ph.D. Thesis) 1967 78 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-5824

The Lawrence Radiation Laboratory 25-inch deuterium bubble chamber was exposed to a beam of K− mesons having laboratory momenta between 815 and 1105 MeV/c. The angular distributions and $\Lambda$ polarizations in the reaction $K^- n \rightarrow \Lambda\pi^-$ were measured in the center-of-mass energy interval 1660 to 1900 MeV. A partial-wave analysis of the angular distributions and polarizations from $K^- n \rightarrow \Lambda\pi^-$ and the total-cross-section data from $K^- p \rightarrow \Lambda\pi^0$ has yielded information on the quantum numbers, resonance parameters, and SU(3) assignments for four $Y_1^*$ resonances. The spin-parity assignments for $Y_1^*(1765)$ and $Y_1^*(2030)$ have been confirmed, and the $Y_1^*(1765)$ mass, width, and $\Lambda\pi$ branching ratio have been measured as 1772 ± 6 MeV, 120 ± 17 MeV, and 0.15 ± .02 respectively. A tentative spin-parity assignment for $Y_1^*(1660)$ and $Y_1^*(1915)$ was also made.
Dissert. Abstr.

**N69-12964** California Univ., San Diego.
**ELECTRON-ION AND ION-ION DISSOCIATIVE RECOMBINATION OF OXYGEN**
Fui Tak Chan (Ph.D. Thesis) 1967 89 p
Avail: Univ. Microfilms: HC $4.60/Microfilm $3.00 Order No. 68-2630

The rate coefficient for electron-molecular oxygen ion is calculated quantum mechanically. The quantum treatment due to Warke is presented in detail. A simple one-electron model is used. The positive molecular ion is approximated by a rotating dumbbell consisting of $O(^3P)$ and $O^+(^4S)$, and the electron-atomic oxygen interaction is treated as the perturbation for the recombination process. The rate coefficient and the thermal cross section for the oxygen ion-ion dissociative recombination are calculated using the semiclassical formalism. The motion of the heavy particles (positive and negative ions) in their mutual coulomb field is treated classically. At certain ranges of the ion-ion separation (determined from energy conservation), the electron tunnels from the negative ion to the positive ion. Dissert. Abstr.

**N69-12965** Kansas Univ., Lawrence.
**EFFECTS OF THE FEINGOLD THREE-BODY VECTOR OPERATOR IN THE LEVEL STRUCTURE OF THE NUCLEAR 1p SHELL**
James Roger Hill (Ph.D. Thesis) 1967 125 p
Avail: Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 68-590

The second order effects of the tensor operator, known to be important in explaining the $Li^7/N^{15}$ doublet splitting ratio, have been investigated for the natural parity states of the nuclear 1p shell. The shell model Hamiltonian was assumed to contain both one and two-body scalar and vector forces, a two-body tensor force, and the Feingold three-body vector force. The $1p_{1/2}$ and $1p_{3/2}$ orbitals were assumed to have constant size parameter. $(1p)^{A-4}$ configuration functions were taken as basis. The LS reduced matrix elements of the Feingold three-body operator, for $(1p)^{A-4}$ basis functions, were shown to be functions of five parameters. The independent, lowest-configuration reduced matrix elements of the one and two-body operators give rise to 13 additional parameters. The Hamiltonian matrices of the 1p shell nuclei were calculated by the Coefficient of Fractional Parentage chain method. Dissert. Abstr.

**N69-12967#** International Centre for Theoretical Physics, Trieste (Italy).
**ON THE DIVERGENT PART OF THE SECOND-ORDER ELECTROMAGNETIC CORRECTIONS TO THE RATIO $G_A/G_V$**
A. Sirlin Aug. 1968 34 p refs
(IC-68/75) Avail: CFSTI

The divergent part of the second-order electromagnetic corrections to the axial vector matrix elements is studied, using a simple extension of the Bjorken limit to the case involving the time-ordered product of three currents (or local operators). Under certain conditions it is shown that the second-order corrections to $G_A/G_V$ (in neutron $\beta$ decay) are finite in the simple intermediate boson model. Uncompensated logarithmic divergences in the overall corrections to $G_A/G_V$ are found with coefficients which appear to be highly model dependent. The effect of operator gradient terms and the possible connection with the well-known divergences in the electromagnetic mass shifts is discussed. The case of the $SU_3 \otimes SU_3$ algebra of fields is studied separately. Thus, by applying this method, the case of the algebra of fields Schwinger's interpretation of the Bjorken correction factor is recovered as well as his expressions for the divergent parts of the mass shifts of the charged vector and axial vector mesons. NSA

**N69-12970#** Israel Atomic Energy Commission, Tel Aviv.
**RESEARCH LABORATORIES Annual Report, Jan.–Dec. 1967**
Apr. 1968 256 p refs
(IA-1168) Avail: CFSTI

Brief summaries are presented of the research work carried out during the period January–December, 1967. Author (NSA)

**N69-12972#** Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Experimentelle Kernphysik.
**EXPERIMENTAL INVESTIGATIONS OF THE REACTIONS H(d,2p)n AND D(d,dp)n WITH 50 MeV DEUTERONS**
H. Brueckmann, W. Kluge, and L. Schaenzler Jul. 1967 20 p refs Presented at the Symp. on Light Nuclei, Few Body Probl., and Nucl. Forces, Brela, Yugoslavia
(KFK-608; CONF-670629-9) Avail: CFSTI

A collimated beam of 51.5 MeV deuterons from the Karlsruhe isochronous cyclotron was used to investigate the three particle reactions $p + d \rightarrow n + p + p$ and $d + d \rightarrow d + p + n$. The two emitted protons or the proton and the deuteron, respectively, were detected in coincidence with two scintillation counters. The experimental data for the reaction p(d,pp)n exhibit a pronounced peak due to final state interaction between the outgoing neutron and one proton (the proton angles were chosen to be $\Theta_{lab} = 40°$ and $\Theta_{lab} = 25°$ accordingly). The analysis shows that this final state interaction is dominated by the virtual singlet state of the deuteron. The extracted n-p scattering length is $|a_s| = 19 \pm 2.5$ f. In the investigation of the reaction d(d,dp)n the angles were chosen so as to observe predominantly the process where the neutron in the target deuteron acts as a spectator particle. Author (NSA)

**N69-13029** Brown Univ., Providence, R. I.
**ENERGY ESTIMATION OF PHOTON CASCADE SHOWERS APPLIED TO NEGATIVE PION PLUS p YIELDS n PLUS GAMMA'S AT 1.5 GeV/c**
Robert Frederick Hargraves, Jr. (Ph.D. Thesis) 1967 121 p
Avail: Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 68-1460

An experiment was performed which studied the reaction $\pi^- + p \rightarrow$ neutrals by means of spark chambers designed to detect photons. The laboratory momentum of the incident pion was 1.5 GeV/c. The four spark chambers each consisted of 50 plates of .113 radiation length of iron. Showers in the spark chambers were induced by photons from $\pi^-$ interacting in the hydrogen target. The energies of the showers were estimated by counting the numbers of sparks observed in the gaps. The estimated energies of the showers were adjusted to satisfy the kinematical constraints of a particular hypothesis of particle production. In the last reaction the $\pi^0\pi^0$ interaction was studied and compared to the predicted resonances $\sigma^0$(400 MeV) and $\epsilon^0$(700 MeV). There was evidence of the formation of 3–3 isobar $N^*(1236)$. Dissert. Abstr.

**N69-13032** Wisconsin Univ., Madison.
**RESONANCE STATES IN NUCLEAR REACTION THEORY**
William Joseph Romo (Ph.D. Thesis) 1967 204 p
Avail: Univ. Microfilms: HC $9.25/Microfilm $3.00 Order No. 67-12155

A study is made of a many-channel scattering problem which arises in low energy nuclear physics. Special attention is paid to the discrete spectrum of states which have outgoing boundary condition, that is the bound states and resonances of the system. Resonance state wave functions unlike bound state wave functions are badly behaved in the asymptotic region, growing exponentially with particle separation. As a consequence matrix elements involving resonance states can not be defined by the usual prescription. To

overcome this difficulty a generalized definition of matrix elements is introduced. Under the new definition matrix elements involving resonance states are well defined, and furthermore the definition has the desirable feature of reducing to the old definition when one is considering real energy states. It is shown that the set of bound and resonance states form an orthonormal set with respect to the inner product associated with the new prescription. Dissert. Abstr.

**N69-13033** Ohio Univ., Athens.
**WAVE FUNCTIONS FOR ODD-ODD DEFORMED NUCLEI**
Charles Thomas Hess (Ph.D. Thesis) 1967 154 p
Avail: Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 68-1948

The aim of the dissertation is to propose and test a theoretical model for deformed odd-odd nuclei. It is an extension of the existing theories for odd-odd nuclei. It is also intended to be an extension to the testing of the unified model of Mottelson and Nilsson, since their work was limited to odd-even and even-odd nuclei. Furthermore, it is a test of the form factors and exchange strengths of residual interactions. Although the model is applicable to the strongly deformed regions $A \cong 25$, $150 \leq A \leq 180$, and $A \cong 225$, testing of the model was done for the rare earth region, $150 \leq A \leq 180$. The testing is further restricted to nuclei with at least two clearly defined band heads of experimental data, both in the odd-odd nucleus calculated and in the odd-even and even-odd nuclei needed for the calculations. Dissert. Abstr.

**N69-13041#** United Kingdom Atomic Energy Authority, Harwell (England).
**LIST OF RADIOACTIVE ISOTOPES IN ASCENDING ORDER OF HALF-LIFE**
R. J. Bullock and N. R. Large Jun. 1968 45 p refs
(AERE-M-2058) Avail: Issuing Activity

The radioactive isotopes listed in Table of Isotopes, 6th Edition, (John Wiley & Sons, N.Y., 1967) have been arranged in order of ascending half life by a computer program, to assist in the identification of isotopes of which only the half life is known. Author (NSA)

**N69-13048#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
**METHOD OF CONSTRUCTION OF THE ELASTIC SCATTERING APPROXIMATE AMPLITUDE**
P. S. Isaev, Kh. D. Popov, and I. S. Zlatev 1968 29 p refs
(JINR-E-2-3989) Avail: CFSTI

A method is suggested for constructing the elastic meson scattering amplitude, satisfying, in all three channels, the exact conditions of analytics, crossing symmetry, and two-particle unitarity near the physical threshold and an approximate unitarity condition on the cut. The analytic properties of partial amplitudes are considered. It is shown that the dynamics of the scattering process are defined by the singularities lying on the unphysical sheet. Author (NSA)

**N69-13061** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**MOLECULAR COLLISIONS**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 1-3 refs (See N69-13060 03-34)
(Contract DA-28-043-AMC-02536(E))
Avail: CFSTI

Angular distribution curves are given for cesium and potassium beam scattering on $SO_2$. NSA

**N69-13066** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**MAGNETIC RESONANCE**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 45-46 (See N69-13060 03-34)
(Contract DA-28-043-AMC-02536(E))
Avail: CFSTI

A new method is proposed to reduce the static magnetic dipole-dipole interactions in a solid without limit (as occurs in a liquid through averaging of the angle factors in the dipole-dipole Hamiltonian). It involved the repeated application of a cycle of three equally spaced pulses. The first and third of these were 90° RF pulses differing in carrier phase by 90°, the second was twice as long and had its phase switched by 90° at the center. When the period of this cycle of pulses becomes small compared with the natural transverse relaxation time of the spin system, the system behaves as though it were subject to a time-independent Hamiltonian, which is the average of the successive operators through which the actual Hamiltonian is transformed by the rotations corresponding to the pulses. The detected precessing magnetization that results from the application of such a pulse train is oscillatory. Its Fourier transform is identical to the steady-state unsaturated flow passage NMR spectrum that would be obtained if dipolar interactions were absent, and the Zeeman field intensity were reduced by a factor of $\sqrt{3}$. B.P.

**N69-13076#** Academy of Sciences (USSR), Moscow.
**SINGLE-PARTICLE PROTON STATES OF RARE-EARTH NUCLEI. NEUTRON AND PROTON E1 TRANBITIONS**
V. A. Chepurnov 1967 24 p refs In RUSSIAN
(IAE-1447) Avail: CFSTI

Single-particle proton states in the Woods-Saxon potential at $150 < A < 190$ are examined by numerical integration of the boundary value problem. A comparison is made of the structure of the states and the radial dependence of the amplitudes with the results obtained by methods of diagonalization. Single-particle neutron and proton E1 transitions are examined. NSA

**N69-13077#** Israel Atomic Energy Commission, Tel Aviv.
**NEUTRON CAPTURE GAMMA RAYS FROM NATURAL TITANIUM**
J. Tenenbaum, B. Arad, G. Ben-David, and R. Moreh Jan. 1967 34 p refs
(IA-1102) Avail: CFSTI

Neutron capture gamma rays of Ti were studied using 30-cc and 10-cc coaxial Ge (Li) detectors. More than 65 lines, including about 25 new hitherto unknown lines, were identified. Energies and intensities were determined using the chlorine neutron capture gamma ray spectrum as a reference. Author (NSA)

**N69-13079#** Israel Atomic Energy Commission, Tel Aviv.
**SOME COLLIMATION PROBLEMS IN NEUTRON DIFFRACTOMETRY**
A. Epstein and H. Shaked Dec. 1967 17 p refs
(IA-1167) Avail: CFSTI

Two experimental curves of full width at half maximum (WHM) versus the resolution parameter $a = \tan\theta/\tan\theta_M$ are given. The mosaic spread, $\beta$, of the Cu (002) monochromator is obtained by searching for the best fit between the theoretical and experimental curves. The general behavior of luminosity, WHM, is discussed in view of some theoretical computations. Author (NSA)

**N69-13080#** Israel Atomic Energy Commission, Tel Aviv.
**PRECISION STUDY OF HIGHLY EXCITED NUCLEAR LEVELS USING A GAMMA MONOCHROMATOR**
R. Moreh and G. Ben-Yaacov Feb. 1967 34 p refs
(IA-1163) Avail: CFSTI

A gamma monochromator using resonantly scattered neutron capture gamma beams, which was designed for study of highly excited nuclear levels, is described. Preliminary results concerning resonance levels in heavy nuclides are presented. NSA

**N69-13122#** Mound Lab., Miamisburg, Ohio.
**SCATTERING OF HELIUM ATOMIC BEAMS IN RARE GASES**
Hans-Joachim Beier 3 Sep. 1968 22 p refs Transl. into ENGLISH from Z. Physik (Berlin), v. 196, 1966 p 185–202
(MLM-1553(tr)) Avail: CFSTI

The scattering of helium atomic beams in rare gases is investigated by measurements of total scattering cross sections. With the device described the dependence of total scattering cross sections on the relative velocity of the scattering atoms was measured. For variation of the beam velocity in the range of 1:8 a helium beam source was used which could be cooled down with liquid helium from room temperature to 4.8°K. The detector is of the universal-detector-type. A Wien filter is used as mass filter. The lowest detectable particle density is $6.3 \times 10^3$ He atoms/cm$^3$. The measured scattering cross sections are in qualitative agreement with the theory of the Bernstein. Author (NSA)

**N69-13128#** Atomic Power Development Associates, Inc., Detroit, Mich.
**EVALUATED NEUTRON CROSS SECTIONS OF $Pu^{240}$ FOR THE ENDF/B FILE**
T. A. Pitterle and M. Yamamoto Jun. 1968 60 p refs
(Contract AT(11-1)-865)
(APDA-218; ENDF-122) Avail: CFSTI

Data were evaluated from $10^{-4}$ to 15 MeV for the following neutron reactions: total, n–$\gamma$, fission, (n,2n), (n,3n), elastic scattering including Legendre polynomial expansions of the angular dependence, nonelastic, and inelastic scattering including resolved levels. Graphs of the evaluated data are included. Author (NSA)

**N69-13152*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
**RESONANCE INTEGRALS OF RHENIUM FOR A WIDE RANGE OF SAMPLE SIZES**
Clarence R. Pierce, Donald F. Shook, and Donald Bogart
Washington Dec. 1968 22 p refs
(NASA-TN-D-4938) Avail: CFSTI CSCL 11F

Resonance integrals were measured for $^{185}Re$, $^{187}Re$, and natural rhenium for foil and filth thicknesses from 0.12 to about $10^{-9}$ centimeter using both activation and reactivity methods. The thinnest samples yielded dilute resonance integral values of $1790 \pm 60$, $323 \pm 20$, and $866 \pm 35$ barns for $^{185}Re$, $^{187}Re$, and natural rhenium, respectively. Resonance integrals calculated for the range of sample size using recently measured resonance parameters to 100 electron volts were found to be lower than the measured values by about 10 percent. Author

**N69-13169#** Physikalisches Staatsinstitut, Hamburg (West Germany). Institut fuer Experimentalphysik.
**ANNUAL REPORT, 1966 [JAHRESBERICHT 1966]**
Jan. 1968 58 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-68-01) Avail: CFSTI

Research includes experimental and theoretical studies in the fields of nuclear and high-energy physics. Concerning nuclear physics investigations, stress is laid mainly on nuclear spectroscopy and the study of the reaction mechanism. These experiments are performed with a 3-MeV Van de Graaff generator and by means of radioactive sources. High-energy physics is investigated especially by analysis of photographs taken in the bubble chambers and by studies of production processes of elementary particles. Author (NSA)

**N69-13177#** Gt. Brit. National Inst. for Research in Nuclear Science, Chilton. Rutherford High Energy Lab.
**A USER GUIDE TO THE ENDIM PROGRAMME**
G. R. Stevenson Nov. 1967 12 p refs
(RHEL/M-135) Avail: CFSTI

The computer program ENDIM, which was written to unfold neutron energy spectra from the outputs of a number of detectors with energy-dependent response, is described. The program is written in FORTRAN IV for the IBM 360-75. A listing of the program in included. NSA

**N69-13186#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
**MESON GENERATION BY MESONS AND DOUBLE-RECHARGE OF PI MESONS IN PHOTOEMULSION NUCLEI AT ENERGIES FROM 210 TO 375 MeV**
Yu. A. Batusov, S. A. Bunyatov, V. M. Sidorov, V. A. Yarba, G. Ionitse et al 1968 9 p refs In RUSSIAN
(JINR-PI-3947) Avail: CFSTI

The process of double $\pi^-$ meson charge exchange at energies above the threshold of meson production was studied. Cross sections for meson production and double charge exchange in $\pi^- + A \rightarrow \pi^+ A' + \ldots$ and $\pi^- + A \rightarrow \pi^+ + \pi^- + A' + \ldots$ reactions were measured in the energy range from 210 to 375 MeV. Author (NSA)

**N69-13188** St. Louis Univ., Mo.
**PHOTON-PHONON DOUBLE RESONANCE IN ELECTRON-NUCLEAR SPIN SYSTEMS**
Sister Duns Scotus Breitbart (Ph.D. Thesis) 1967 177 p
Avail: Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 68-1212

Nuclear magnetic resonance may be detected acoustically as well as electromagnetically. In acoustic nuclear magnetic resonance (ANMR), the nuclear spin transitions depend on the existence of a nuclear quadrupole moment. Allowed resonance absorptions for ANMR are characterized by the selection rules, $\Delta m = \pm 1$, $\Delta m = \pm 2$, whereas for conventional nuclear magnetic resonance (CNMR) they are characterized by only $\Delta m = \pm 1$ where $m$ is the nuclear spin magnetic quantum number. It is proposed here that ANMR be used to detect dynamic nuclear orientation produced by the Jeffries–Abragam, or Solid State, effect. This can be achieved experimentally by means of new types of double resonance techniques which consist of conventional electron spin resonance (ESR) and acoustic nuclear magnetic resonance. It is well-known that dynamic nuclear orientation can also be detected by ESR-CNMR double resonance. Dissert. Abstr.

**N69-13189** Wisconsin Univ., Madison.
**SPIN-PHONON INTERACTIONS OF PARAMAGNETIC IONS IN MAGNESIUM OXIDE**
Geoffrey Thomas Fox (Ph.D. Thesis) 1967 53 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 67-12119

The thermal magnetoresistivity of lightly doped single crystals of MgO has been measured over the temperature range from 0.4°K to 4.2°K in magnetic fields up to 40 kilogauss. Resonant absorption

of phonons is observed due to both the $\Delta M = 1$ and $\Delta M = 2$ transitions in the ground state triplet of the $Fe^{2+}$ ion. Theoretical consideration of this ion alone is sufficient to explain the observed data at the lowest temperatures. Deviations from this form are observed at higher temperatures, however. These deviations occur at high magnetic fields and are thought to be due to the excited levels of the $Cr^{2+}$ ion. Unfortunately, a precise knowledge of the energy levels of the $Cr^{2+}$ ion in MgO is lacking and thus a detailed accounting of its effect is not possible. Zero field measurements indicate that nonresonant absorption by the $Cr^{2+}$ ion is important above 1°K. Dissert. Abstr.

**N69-13190** Illinois Univ., Urbana.
**ELECTROABSORPTION EFFECTS NEAR THE DIRECT AND INDIRECT EDGES OF GERMANIUM**
Francisco Alcides Germano (Ph.D. Thesis) 1967 94 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-1754

The effect of an electric field on the optical absorption near the fundamental edge of germanium was measured, employing ac electroabsorption techniques, from 14 to 300°K with electric fields varying from $5\times10^3$ V/cm to $5\times10^4$ V/cm. The curves of the field induced differential absorption coefficient $\Delta\alpha$ exhibit oscillations which, in the case of the direct edge spectrum, are satellite oscillations related to the Franz–Keldysh effect near a $M_0$ edge, modified by excitonic effects; in the case of the indirect edge they are due to the electric-field induced change in the optical absorption assisted by phonon emission and absorption. The electric field dependence of the width of the oscillations in $\Delta\alpha$ above the direct energy gap agrees with the theory derived from an effective mass approximation. Analysis of the data below the gap resulted in an effective mass of 0.022 m at room temperature and 0.024 m at the lower temperatures. Dissert. Abstr.

**N69-13207#** Technische Hochschule, Karlsruhe (West Germany). Institut fuer Struktur der Materie.
**ANALYTICAL TREATMENT OF ARBITRARY ANISOTROPIC SCATTERING IN THE ENERGY-DEPENDENT TRANSPORT THEORY [DIE ANALYTISCHE BEHANDLUNG BELIEBIG ANISOTROPER STREUUNG IN DER ENERGIEABHAENGIGEN TRANSPORTTHEORIE]**
S. A. W. Gerstl Apr. 1968 4 p refs in GERMAN; ENGLISH summary
(BMwF-FBK-68-12) Avail: CFSTI

A general method is outlined to solve the one-dimensional energy and angular dependent transport equation in slab geometry, whereby any anisotropy of the scattering cross section can be treated analytically exact. The angular dependency of the scattering cross section is described in a very general form by means of anisotropy functions for which detailed analytic expressions and recurrence formulas are stated. The quality of this method is demonstrated by shielding calculations for gamma rays. Here, the spectra of the transmitted and reflected energy flux show new discontinuities which attain immediate physical interpretations but were not minded before. Author (NSA)

**N69-13208#** Illinois Univ., Urbana.
**STUDY OF $4\pi$ ENHANCEMENTS IN NEGATIVE PION p AT 5.0 AND 7.5 GeV/c**
G. Ascoli, C. A. Bridges, H. B. Crawley, R. Hanft, A. Shapiro et al [1968] 11 p refs Presented at 14th Intern. Conf. on High Energy Phys., Vienna, 28 Aug.–6 Sep. 1968
(COO-1195-134; CONF-680809-25) Avail: CFSTI

Results are presented of a study of $4\pi$ mass spectra obtained in 5.0- and 7.5-GeV/c $\pi^-$p 4-prong interactions. Evidence was found for a fairly strong enhancement in the $(A_2\pi)^0$ spectrum. NSA

**N69-13210*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
**MINIMIZATION OF OPTICAL SCATTERING EFFECTS THROUGH USE OF OPTIMAL MONOCHROMATOR SLIT GEOMETRY**
Richard Lee Ponting Washington Dec. 1968 12 p refs
(NASA-TM-X-1702) Avail: CFSTI CSCL 20F

The object of this calculation was to determine whether the effects of the scattering of resonance radiation on the data taken from an excitation cross section chamber could be minimized by adjusting the monochromator slit geometry. The study was done on a high speed digital computer, using random numbers to pick the scattering parameters. This method is shown to give an average number of scatters per photon in agreement with previous studies of the integral equation for the scattering process. Further results of the calculation show that adjustment of the nomochromator slit geometry can minimize the effect of scattering and indicate the form this geometry should take. Author

**N69-13224#** Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.
**ASYMPTOTIC SU(3) AND $K_{13}$ DECAY FORM FACTORS**
Prem P. Srivastava 1968 8 p refs *Its* Notas de Fis., Vol. 14, No. 2
Avail: CFSTI

The hypothesis of the validity of asymptotic SU(3) symmetry for high energies and large momentum transfers is applied to the $K_{13}$ and $\pi_{13}$ decay form factors when some of them may satisfy subtracted dispersion relation. Author

**N69-13269#** European Organization for Nuclear Research, Geneva (Switzerland).
**ECFA: EUROPEAN COMMITTEE FOR FUTURE ACCELERATORS, REPORT 1967**
15 May 1967 125 p refs
(CERN/ECFA-67/13-Rev-2; CERN-700) Avail: CFSTI

A study of the design and utilization of a 300-GeV proton synchrotron and a survey of the state of high-energy physics in CERN member states are presented. Conclusions and recommendations of the ECFA are summarized. NSA

**N69-13273#** Illinois Univ., Urbana.
**A STUDY OF THE POSITIVE KAON-p INTERACTION AT 3.2 AND 2.75 GeV/c**
G. S. Abrams, L. Eisenstein, T. A. O'Halloran, Jr., W. Shufeldt, and J. Waltmore [1968] 15 p refs Presented at 14th Intern. Conf. on High Energy Phys., Vienna, 28 Aug.–6 Sep. 1968
(COO-1195-130; CONF-680809-18) Avail: CFSTI

Preliminary results are reported on a study of the $K^+ p \rightarrow K^+\pi^-\pi^+p$ interaction at 3.2 and 2.75 GeV/c in the ANL 30" hydrogen bubble chamber. At both energies the final state is dominated by the production of $K^{*0}$ (890) and $N^{*++}$ (1238) resonances. A maximum likelihood fit to the data was performed assuming four noninterfering amplitudes ($K^{*}N^{*}$, $K^{*}p\pi^+$, $K^+\pi^-N^{*}$, and nonresonant $K^+\pi^-p\pi^+$). NSA

**N69-13284#** Illinois Univ., Urbana.
**MASS SPECTRUM (3 $\pi$) PRODUCED BY NEGATIVE PION p AT 5 AND 7.5 GeV/c**
G. Ascoli, C. A. Bridges, H. B. Crawley, E. D. Schafer, D. W. Mortara et al [1968] 10 p refs Presented at 14 Intern. Conf. on High Energy Phys., Vienna, 28 Aug.–6 Sep. 1968
(COO-1195-132; CONF-680809-19) Avail: CFSTI

The $\pi^+\pi^-\pi^-$ mass spectrum produced in $\pi^-$p interactions was studied for the mass interval 1.0 to 1.4 GeV. The data were

taken from 55,000 events obtained at 5 GeV/c in a 72" chamber and 22,000 events at 7.5 GeV/c in an 80" chamber. NSA

N69-13285# Illinois Univ., Urbana.
**A MEASUREMENT OF THE RATIO GAMMA (NEGATIVE KAON YIELDS NEGATIVE PION NEUTRAL PION NEUTRAL PION)/GAMMA (POSITIVE KAON YIELDS POSITIVE PION NEUTRAL PION NEUTRAL PION) OF THE TAU PRIME PARTIAL DECAY RATES**
D. P. Herzo, E. W. Beier, D. Banner, R. T. Edwards, and W. K. Bertram 1967 13 p refs Presented at 14th Intern. Conf. on High Energy Phys., Vienna, 28 Aug.–5 Sep. 1968
(COO-1195-128; CONF-680809-23) Avail: CFSTI

An experimental determination of the ratio of the decay rates $\Gamma(\tau'-)/\Gamma(\tau'+)$ yielded no evidence for a CP violating $\Delta I = 5/2$ amplitude in the $\tau$ decays. NSA

N69-13302# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.
**INTRODUCTION TO RADIATION PHYSICS, CHAPTER 8, PART 1 [INTRODUZIONE ALLA FISICA DELLE RADIAZIONI, CAPITOLO 8, PARTE 1]**
U. Amaldi, Jr. 3 May 1968 87 p refs In ITALIAN; ENGLISH summary
(ISS-68/14-Pt-1) Avail: CFSTI

This issue is devoted to the description of the interactions of charged particles with matter, and in particular to collision losses which cause excitations and ionizations of atoms and molecules and produce secondary electrons. Author

N69-13361*# Volt Information Sciences, Inc., Washington, D. C.
**ON ELECTRODYNAMICS OF A GYROTROPIC MEDIUM**
A. A. Kolomenskiy Greenbelt, Md. Goddard Space Flight Center 3 Dec. 1968 12 p refs Transl. into ENGLISH from Zh. Eksperim. I Teor. Fiz., (Moskva, USSR), v. 24, 2d Ed., 1953 p 167–176
(Contract NAS5-12487)
(NASA-CR-97914; ST-EDN-10782) Avail: CFSTI CSCL 20H

Formulas are obtained for the radiating energy and the radiation field of charges moving in a gyrotropic medium. These formulas are applied to the case of oscillator rotation and also to the case of radiation of an electron moving in a given medium with constant velocity (Cerenkov effect). Author

N69-13385# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.
**INTRODUCTION TO RADIATION PHYSICS, CHAPTER 8, PART 2 [INTRODUZIONE ALLA FISICA DELLE RADIAZIONI, CAPITOLO 8, PARTE 2]**
U. Amaldi, Jr. 10 Jul. 1968 112 p refs In ITALIAN; ENGLISH summary
(ISS-68/23-Pt-2) Avail: CFSTI

In this issue the concepts of mean energy per ion pair and of linear energy transfer are introduced and the radiation of quanta in the electric field of atomic nuclei described. A discussion of the ranges of heavy particles and electrons concludes the study of the interactions of charged particles in matter. Author

N69-13433 European Organization for Nuclear Research, Geneva (Switzerland).
**FOURTH-ORDER COUPLING RESONANCE EXCITED BY SPACE-CHARGE FORCES IN A SYNCHROTRON**
B. W. Montague 29 Oct. 1968 49 p refs
(CERN-68-38) Avail: Issuing Activity

The coupled motion between two transverse coordinates of a particle beam arising from the space–charge forces is analyzed mathematically. In particular, the effects of the coupling in beams which have unequal emittance in the two planes (flat beams) is dealt with. The problem was examined by solving a pair of second-order, coupled, nonlinear differential equations using an adaptation of the classical method of varying amplitude and phase. The discussion is centered around the effects in an AG synchrotron. An outline of the Schoch nonlinear theory as applied to the problem is presented and the basic perturbation Hamiltonian for the space–charge potential of a Gaussian distribution is derived. B.P.

N69-13492# Naval Research Lab., Washington, D. C.
**TOPICS IN ELECTRON SCATTERING AND NUCLEAR MODELS: NOTES ON LECTURES GIVEN AT NRL IN THE FALL OF 1966**
H. Veberall 31 Jul. 1968 84 p refs
(AD-676307; NRL-6729) Avail: CFSTI CSCL 20/8

A review is presented of the basic theory of electron scattering from nuclei and of photonuclear processes, as well as a discussion of the analysis of electron scattering experiments. This includes cross sections in Born approximation, elastic scattering from nuclei for the study of nuclear moments, and continuum scattering. Particular attention is given to inelastic electron scattering with excitation of nuclear levels, both below and in the giant resonance region. A variety of theoretical models is discussed that describe excitations of nuclear states. Author (TAB)

N69-13504# Maryland Univ., College Park. Dept. of Physics and Astronomy.
**A MEASUREMENT OF THE LONGITUDINAL COMPONENT OF MUON POLARIZATION IN $K_{\mu 3}$ DECAY**
Richard W. Burris Aug. 1968 76 p refs
(Contract AT(40-1)-2504)
(ORO-2504-119; TR-789) Avail: CFSTI

The longitudinal component of muon polarization in the decay $K+ \rightarrow \mu+ + \pi^0 + \nu$ was measured using a counter-controlled spark chamber array. The K+ rate was maximized by using a momentum analyzed beam without mass separation. NSA

N69-13540# Purdue Univ., Lafayette, Ind. Project Squid Headquarters.
**SOME DEVELOPMENTS OF FADDEEV'S THEORY FOR REACTIVE SCATTERING**
B. C. Eu (McGill Univ.) and John Ross (MIT) Sep. 1968 19 p refs Prepared in Cooperation with McGill Univ. and MIT
(Contract N00014-67-A-0226; Proj. Squid)
(AD-676554; MIT-44-PU) Avail: CFSTI CSCL 7/4

The distorted wave Born approximation is shown to hold to second order in the transition matrix elements of Faddeevs theory of three particle scattering, and to hold beyond the limitations given by Greider and Dodd. Faddeev type equations are derived for a real and symmetric reactance matrix. Numerical calculations are facilitated by use of this matrix, and all approximations made on it retain unitarity of the transition matrix. The completeness of expansions for three body scattering problems are briefly commented upon. Author (TAB)

N69-13543# Brookhaven National Lab., N. Y. Physics Dept.
**THE TALE OF TWO "A-2" MESONS**
Kwan Wu Lai [1968] 23 p refs Presented at Particle Phys., Boulder, Colo., Jun. 1968
(BNL-12769; A-194; CONF-680627-1) Avail: CFSTI

The properties of the $A_2$ meson obtained from early bubble chamber experiments are summarized. Results obtained from missing mass experiments at CERN, which yielded evidence of two peaks in the $A_2$ region are reviewed. Data obtained from recent bubble chamber experiments of the $\pi^-p$ interaction a 6 GeV/c

are reviewed and analyzed. The η(1550)π, π+ + neutral, and KK decay modes are discussed. NSA

**N69-13549#** Naval Research Lab., Washington, D. C.
**REPORT OF NRL PROGRESS, OCTOBER 1968**
Oct. 1968 37 p refs
Avail: CFSTI

The 180-degree inelastic electron scattering from magnesium-24 has been studied at bombarding energies of 39 and 56 MeV. A survey was made of the giant-resonance region from 14 to 28 MeV. The excitation region from 9 to 14 MeV was treated more intensively in order to study the analogs of states in sodium-24. Measurement of the transition radius (R) and the ground-state transition width (I) for the 9.94- and 10.70-MeV levels yielded $R = (3.5 \pm 0.2)$ fm, $\Gamma = (11.9 \pm 2.7)$ eV and $R = (3.0 \pm 0.2)$ fm, $\Gamma = (18.9 \pm 3.7)$ eV, respectively. The relation of these results to the theory of Kurath is discussed. Author

**N69-13552#** Connecticut Univ., Storrs. Dept. of Physics.
**COINCIDENCE MEASUREMENTS OF ATOMIC COLLISIONS Final Report, 1 Jan. 1965–30 Apr. 1968**
Edgar Everhart Jun. 1968 8 p refs
(Grant AF-AFOSR-805-65)
(AD-676870; AFOSR-68-1721) Avail: CFSTI CSCL 7/4

This describes a program in coincidence measurements of atomic collisions. After a violent single atomic collision both particles are studied to determine their state of ionization (after the collision) and the inelastic energy loss associated with that collision. The argon ion-atom collision, and similar neon and krypton collision are studied. In some cases structure is found in the inelastic energy losses wherein two or three discrete values of this energy loss are found at certain energies on scattering angles. The pertinent region for argon-argon collisions is at 25 KeV and 16 degrees, for neon-neon collisions it is at 200 KeV and 8 degrees, and for krypton-krypton collisions the structure is found at 25 KeV, and 9 degrees. Author (TAB)

**N69-13563#** Maryland Univ., College Park. Dept. of Physics and Astronomy.
**LOW ENERGY LAMBDA-PROTON ELASTIC SCATTERING**
B. Sechi-Zorn, B. Kehoe, J. Twitty, and R. A. Burnstein Jul. 1968 26 p refs
(Contract AT(40-1)-2504)
(ORO-2504-123; TR-846) Avail: CFSTI

The cross sections for (Λ,p) elastic scattering with Λ momenta in the interval 110 to 330 MeV/c have been measured. The results are based on 224 scattering events found in a sample of 95,600 Λ hyperons observed in an exposure of the 81 cm Saclay hydrogen bubble chamber to a stopping K− beam. These cross sections are analyzed in terms of effective range theory. A wide spectrum of solutions in this formalism give acceptable agreement with the data. Author (NSA)

**N69-13641#** Bhabha Atomic Research Centre, Bombay (India).
**ON THE USE OF MODELS IN NUCLEAR STRUCTURE**
R. Ramanna 1968 36 p refs
(BARC-350) Avail: CFSTI

In this paper two situations are discussed where: (1) a model has been applied to a particular reaction, viz. nuclear fission without any special success and where an alternative mathematical analysis is possible which is independent of the model to a first order; and (2) a possibility exists of describing the ground state properties of nuclei using the theory of differential forms based on the topology of the manifold. Instead of considering the process of nuclear fission as resulting only from the deformations of a charged liquid drop, the process is studied as the consequence of a stochastic exchange of nucleons between the two sides of a dividing nucleus. The transition probabilities are evaluated from purely ground state data. Some experiments pertaining to these measurements are discussed. In order to study the ground state properties of nuclei, use is made of the fact that a set of Schrodinger equations can be put into differential forms defined on a Riemann surface or manifold. It is shown that the choice of the manifold and its connectivity determines the ground state nuclear properties such as N–P ratios, Coulomb, binding energies and shell structure. Author

**N69-13650#** Army Nuclear Defense Lab., Edgewood Arsenal, Md.
**A BCD TO BINARY CONVERSION PROGRAM DESIGNED TO OPERATE ON THE NGM CODE OUTPUT**
Lester M. Petrie, Joseph R. Landau, and W. Charles Hampton Oct. 1968 114 p refs
(AD-676837; NDL-TM-53) Avail: CFSTI CSCL 9/2

A set of editing codes has been developed to integrate (with or without weighting) the differential fluxes calculated by the Neutron Gamma Monte Carlo (NGM) atmospheric transport of radiation code, which is being prepared by Los Alamos Scientific Laboratory (LASL). The NGM code output is the radiation flux at various detector points as a function of the source energy and the solid angle in which the radiation left the source, the energy of the radiation at the detector, the time at which it reaches the detector, and the solid angle through which it comes to the detector. The program described in this report takes the Binary Coded Decimal (BCD) output of the NGM code and converts it to binary, which is the form of input acceptable by the USANDL editing codes. The conversion program is written in the Valley Forge Assembly Program (VFAP) language for a GE 225 digital computer having a 16k core storage and six magnetic tape drives. Author (TAB)

**N69-13659#** Stanford Univ., Calif. Dept. of Physics.
**THEORETICAL STUDIES IN ELEMENTARY PARTICLES, NUCLEAR AND LOW-TEMPERATURE PHYSICS Final Scientific Report, 1964–1968**
L. I. Schiff Jul. 1968 19 p
(Contract AF 49(638)-1389)
(AD-676700; AFOSR-68-1426) Avail: CFSTI CSCL 20/8

Research in theoretical physics has been performed in the following areas: electromagnetic and nuclear structure of H3 and He3; electron scattering from heavier nuclei including magnetic effects; giant magnetic quadrupole oscillations in nuclei; symmetry schemes in the classification of elementary particles and resonances; nucleon electromagnetic form factors and the pion-pion interaction; quark models of hadrons; new techniques in quantum field theory and some characteristics of the weak interaction; general relativity and gravitation; properties of quantized flux lines in superconductors and of vortices in liquid helium. Author (TAB)

**N69-13739#** Oregon State Univ., Corvallis. Dept. of Physics.
**NUCLEAR PHYSICS GROUP ANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1968**
Jul. 1968 88 p refs
(Contract AT(45-1)-1062)
(RLO-1062-681) Avail: CFSTI

The experimental research program dealt with α inelastic scattering by $^{90}Zr$, electric deuteron polarization in stripping reactions, and decay of $^{109}Pd$ and $^{111}Pd$, while the theoretical research program dealt with charge-exchange reactions, antisymmetric nuclear scattering, coupled-channel codes, the (p,n) reaction on $^{14}C$, coupled-channel wave functions in rearrangement collisions, first-order nuclear transition rates, nuclear structure

calculations, low-energy nucleon tunneling in heavy-ion reactions, intermediate resonances, and approximation of nonseparable potentials. The development and modification of the cyclotron facility is also summarized. NSA

**N69-13741#** California Univ., Berkeley. Lawrence Radiation Lab.
**K+p INTERACTIONS NEAR 1 GeV/c**
R. W. Bland, G. Goldhaber, B. H. Hall, J. A. Kadyk, V. H. Seeger et al. Jul. 1968 25 p refs Presented at the 14th Intern. Conf. on High Energy Physics., Vienna, 28 Aug.–5 Sep. 1968
(Contract W-7405-ENG-48)
(UCRL-18323; CONF-680809-30) Avail: CFSTI

An analysis of film obtained in an exposure of the LRL 25-inch bubble chamber to a separated K+ beam at several momenta between 0.860 and 1.58 BeV/c is presented. The behavior of the elastic and inelastic cross sections, details of the elastic scattering, and the inelastic processes are discussed. NSA

**N69-13743#** California Univ., Berkeley. Lawrence Radiation Lab.
**EXPERIMENTAL EVIDENCE AGAINST THE ANGULAR MOMENTUM NONCONSERVATION SCHEME FOR WEAK INTERACTIONS**
M. Chen Aug. 1968 4 p refs
(Contract W-7405-ENG-48)
(UCRL-18399) Avail: CFSTI

An experiment by Friedell is cited which yields indirect evidence against angular momentum nonconservation in weak interactions. NSA

**N69-13746#** California Univ., Berkeley. Lawrence Radiation Lab.
**APPLICATIONS OF THE LORENTZ GROUP TO REGGE POLE ANALYSIS OF PION PHOTOPRODUCTION**
Jan William Dash 20 Jul. 1968 65 p refs
(Contract W-7405-ENG-48)
(UCRL-18377) Avail: CFSTI

Lorentz invariance and Regge pole theory in the phenomenological study of photoproduction of pions from nucleons and nucleon–nucleon scattering are considered. The kinematics for the more general cases having all unequal and nonzero external masses are worked out, and the limit of equal baryon masses and zero photon mass is taken. The applications of Lorentz symmetry at $t = 0$ are considered, and the photoproduction daughter sequence is obtained. The factorization of the photoproduction Regge residues is shown to be consistent with the conspiracy relations in the nucleon–nucleon and pion Compton scattering processes. The high energy pion photoproduction data along with nucleon–nucleon data assuming the existence of an $M = 1$ pion parity doublet conspiracy are analyzed. The consequences of assuming a square-root type zero or a full zero in the $\pi N\bar{N}$ vertex function are investigated. The possibility of the existence of an $M = 1$ $B$-$\rho$ parity doublet conspiracy is investigated qualitatively through a photoproduction sum rule for the photon isoscalar amplitude, and by requiring consistency between phenomenological fits. Author (NSA)

**N69-13753#** Sydney Univ. (Australia). School of Physics.
**CHARGE EXCHANGE COLLISIONS INVOLVING MULTI-ELECTRON ATOMS (Li AND Na)**
J. G. Lodge and R. M. May Jul. 1968 27 p refs
(NP-17621; TR-21) Avail: CFSTI

The Brinkman–Kramers approximation and a simple effective-Z wave function together with a multiplicative correction factor are used to estimate charge-exchange cross sections for protons on lithium and sodium, and the results are compared with experiment. The lithium case is then extended, first to include the inner electrons and then to a calculation using a more satisfactory wave function. Author (NSA)

**N69-13757#** California Univ., Berkeley. Lawrence Radiation Lab.
**STUDY OF OMEGA AND PHI PRODUCTION IN K+ p INTERACTIONS AT 4.6 AND 9.0 GeV/c**
G. Alexander, A. Firestone, C. Fu, G. Goldhaber, and A. Pignotti Jul. 1968 48 p refs Presented at the 14th Intern. Conf. on High Energy Phys., Vienna, 28 Aug.–5 Sep. 1968
(Contract W-7405-ENG-48)
(UCRL-18321; CONF-680809-29) Avail: CFSTI

Results on the $\omega$ and $\phi$ production in $K^+p \rightarrow K^+\omega p$ and $K^+p \rightarrow K^+\phi p$ interactions at incident momenta of 4.6 and 9.0 GeV/c are presented. There is no statically significant evidence for $K\omega$ or $K\phi$ resonance production. The 437 $K^+\omega p$ events at 9 GeV/c are analyzed in terms of a multiperipheral Regge model on the entire Dalitz plot. The events have been assigned to the various peripheral diagrams on the basis of criteria in the four-momentum transfers. A satisfactory description of the data has been obtained on the basis of diagrams involving Pomeranchuk and meson exchanges. Author (NSA)

**N69-13762#** Princeton Univ., N. J. Palmer Physical Lab.
**MEASUREMENT OF THE BRANCHING RATIO K SUB L YIELDS 2 PI SUP 0/K SUB L YIELDS 3 PI SUP 0**
M. Banner, J. W. Cronin, J. K. Liu, and J. E. Pilcher 14 Aug. 1968 18 p refs
(Contracts AT(30-1)-2137; N0014-67-A-0151-0001)
(PPAR-2) Avail: CFSTI

The branching ratio $(K_L \rightarrow 2\pi^0)/(K_L \rightarrow 3\pi^0)$ was measured to be $(4.6 \pm 1.1) \times 10^{-3}$. Combined with a recently reported branching ratio $(K_L \rightarrow 3\pi^0)/(K_L \rightarrow \text{all modes}) = (0.209 \pm 0.011)$, it was found that $(K_L \rightarrow 2\pi^0)/(K_L \rightarrow \text{all modes}) = (0.96 \pm 0.23) \times 10^{-3}$, and $|\eta_{00}| = (2.3 \pm 0.3) \times 10^{-3}$. Author (NSA)

**N69-13763#** Princeton-Pennsylvania Accelerator, Princeton, N. J.
**EXTRACTING MATRIX ELEMENTS FROM THE LEE-DALITZ PLOT**
Sherman Frankel and Olin Van Dyck 17 Aug. 1968 25 p ref
(Contract AT(30-1)-2137)
(PPAR-4) Avail: CFSTI

The orthogonal functions are used to express the density of points observed on a Lee–Dalitz plot and the matrix elements are extracted without recourse to the Lee transformation. The extraction methods are applicable for any orthogonal function. Also, the value to the experimentalist of using orthogonal functions in searching for nonstatistical errors in the data is illustrated with an example from the current literature. NSA

**N69-13764#** Princeton Univ., N. J.
**1029-KEV LEVEL IN $^{200}$Hg**
P. K. Hopke, R. A. Naumann, and E. H. Spejewski 12 Aug. 1968 10 p refs
(Contract AT(30-1)-2137)
(PPAR-5) Avail: CFSTI

A search for 1029-keV photons following the decay of $^{200}$Tl was made. These were observed and led to an assignment of spin 2 to the 1029-keV level in $^{200}$Hg. The relative intensity, $I_{1029}/I_{661}$, is 0.048 ± 0.003. Author

**N69-13781#** Princeton Univ., N. J. Palmer Physical Lab.
**MEASUREMENT OF THE BRANCHING RATIO $K_L$ YIELDS GAMMA GAMMA/$K_L$ YIELDS 3 $PI^0$**
M. Banner, J. W. Cronin, J. K. Liu, and J. E. Pilcher 12 Aug. 1968 14 p refs
(Contracts AT(30-1)-2137; N0014-67-A-0151-0001)
(PPAR-1) Avail: CFSTI

The branching ratio $(K_L \rightarrow \gamma\gamma)/(K_L \rightarrow 3\pi^0)$ was measured to be $(2.24 \pm 0.28) \times 10^{-3}$. Combined with a recently reported branching ratio $(K_L \rightarrow 3\pi^0)/(K_L \rightarrow \text{all modes}) = 0.209 \pm 0.011$, $(K_L \rightarrow \gamma\gamma)/(K_L \rightarrow \text{all modes})$ was found to be $(4.68 \pm 0.64) \times 10^{-4}$. Author (NSA

**N69-13788#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation.

**EFFECT OF THE COULOMB COLLISIONS OF PARTICLES ON THE NONLINEAR TRANSVERSE WAVE INTERACTIONS**

V. G. Makhankov and B. G. Shchinov 1968 10 p refs In RUSSIAN

(JINR-P9-4040) Avail: CFSTI

The effect of the Coulomb collisions on the nonlinear interactions of transverse waves is considered. It is shown that the method developed for the Langmuir waves can be easily transferred on the case in question. Author (NSA)

**N69-13806#** Massachusetts Inst. of Tech., Cambridge. Nuclear Science Lab.

**INCONSTANCY OF MEAN RADII OF NUCLEAR STATES IN ROTATIONAL BANDS**

Lee Grodzins 9 Sep. 1968 37 p refs Presented at the Intern. Symp. on Nuclear Structure, Dubna, Jul. 1968

(Contract AT(30-1)-2098)

(MIT-2098-479) Avail: CFSTI

The difference, $\Delta\langle R^2\rangle$ in the mean square radius of the first 2+ state with respect to the 0+ ground state of rotational bands has now been measured for a number of deformed nuclei using Moessbauer and muonic isomer shift techniques. The results of both types of measurements are reviewed. The derivation of $\Delta\langle R^2\rangle$ from Moessbauer data still contains up to 50% uncertainty in the evaluation of $|\Psi(0)|^2$. The muonic data are superficially more reliably analyzed. There are, however, large corrections for energy shifts resulting from asymmetries in the decay of the magnetically split nuclear transition. And there are further ambiguities in evaluating polarization effects. Considering the overall uncertainties, the results of the two techniques are in good accord. On the other hand the theoretical predictions of $\Delta\langle R^2\rangle$ are uniformly several times larger than the experimental values. Author (NSA)

**N69-13813#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics.

**MULTIPLE SCATTERING OF 94 TO 294 KEV HYDROGEN IONS IN A MUSCOVITE**

A. M. Govorov, V. I. Selatskii, and S. A. Telazhnikov 1968 13 p refs In RUSSIAN

(JINR-P15-3998) Avail: CFSTI

Measurements of multiple scattering of protons and ions in muscovite films at energies from 94 to 294 keV were compared with calculations carried out using Molliére theory and the Thomas–Fermi statistical model for describing electrons in atoms. Data obtained showed that experimental results for the angular distribution half widths are about 17% larger for the whole range of energies than those calculated theoretically. Author (NSA)

**N69-13816#** Nihon Univ. (Japan). Dept. of Physics and Atomic Energy.

**BRANCH CUT CONTRIBUTIONS TO BACKWARD UNEQUAL-MASS SCATTERING PROCESSES**

Takashi Obara 1968 8 p refs

(NUP-A-68-18) Avail: CFSTI

Consideration is given to the contributions of moving branch point $\alpha_c(u)$ in the $l$-plane to the backward unequal-mass scattering amplitude. It is shown that Khuri amplitudes b(u, $\nu$) and c(u, $\nu$) have cuts starting from $\nu = \alpha_c - k$, Re $\nu > -1/2$. The defect of Regge representation owing to unequal-mass kinematics is remedied by introducing the daughter branch point trajectories. Author

**N69-13819#** Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires.

**STUDY OF SOME PROPERTIES OF S NEUTRON RESONANCE PARAMETERS FOR TARGET NUCLEI I = 1/2 AND I = 3/2 IN FUNCTION OF SPIN VALUE J = I±1/2 IN THE ENERGY RANGE 1–5000 eV [ETUDE DE QUELQUES PROPRIETES DES PARAMETRES DE RESONANCE DES NEUTRONS S POUR DES NOYAUX CIBLES I = 1/2 ET I = 3/2 EN FONCTION DE LA VALUER DU SPIN J = I±1/2 DANS LE DOMAINE D'ENERGIE DE 1 eV A 5000 eV]**

Jean Julien (Ph.D. Thesis–Paris Univ., 25 May 1967) Feb. 1968 257 p refs In FRENCH; ENGLISH summary

(CEA-R-3385) Avail: CFSTI

Different kinds of experiments and analysis methods allowing to achieve neutron resonance parameters in the low energy range (1 eV – 5000 eV) are described. A great deal of effort to improve experimental conditions and data processing in order to know the spin value $J = I \pm 1/2$ has been spent. The time of flight method was used. A few target nuclei $I = 3/2$ and $I = 1/2$ have been studied. For $I = 3/2$ (Ga, As, Br, Au) it is found that $S_0$ $J=2 \approx 2$ $S_0$ $J=1$ and $S_0$ $J=1 < S_{X0}$ $J=0$ for $I = 1/2$ (Tm, Pt) but $^{77}$Se. Fluctuations of the total radiative width depend on the spin value $I = I \pm 1/2$ when E1 transitions are enhanced for one of the both spin states. The magnitude of these fluctuations can be explained if it is assumed that the strength of E1 transitions ($E_\gamma \sim 7$ MeV) is supposed to be proportional to E5 instead of E3. The distribution of level spacings against spin value J is considered and compared with theoretical predictions. Author (ESRO)

**N69-13845#** Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics.

**PI-N RESONANCE WIDTHS IN THE BROKEN SL(2,C) MODEL**

K. Szego and K. Toth 28 Aug. 1968 8 p refs

(KFKI-21/1968) Avail: CFSTI

The elastic decay width of some $\pi N$ resonances is evaluated in the SL(2,C) model of Regge-poles. Two families of resonances are examined in the first order of symmetry breaking, one of them has isotopic spin $I = 1/2$, the other $I = 3/2$. The width of other resonances along the trajectories is calculated in symmetry limit and the differential cross section is examined for $\pi N$ backward scattering. The results are in good agreement with experiments. Author (NSA)

**N69-13852#** Yeshiva Univ., New York. Belfer Graduate School of Science.

**STATISTICAL MECHANICS OF EQUILIBRIUM, NON-EQUILIBRIUM AND QUANTUM MANY-BODY PROCESSES Final Report, 1 Oct. 1965–1 Oct. 1967**

Joel L. Lebowitz Dec. 1967 18 p refs

(Grant AF-AFOSR-508-66)

(AD-676668; AFOSR-68-2097) Avail: CFSTI CSCL 20/12

Several general results are obtained for a system of spins on a lattice in which the various lattice sites are occupied at random, and the spins, if present, interact via a general Heisenberg or Ising interaction decreasing sufficiently rapidly with distance. For a system of non-interacting particles which interact with randomly distributed scattering centers Feynmans path integral formulation of quantum statistics is used to derive some properties of the average partition function for one particle. A detailed study has been made of the time evolution of the distribution function of a labeled particle in a one-dimensional system of hard rods of diameter a. The stationary non-equilibrium Gibbsian ensemble representing a

harmonic crystal in contact with several idealized heat reservoirs at different temperatures is shown to have a Gaussian gamma-space distribution for the case where the stochastic interaction between the system and heat reservoirs may be represented by Fokker-Planck type operators. The magnetic properties of a single non-degenerate band with short range intra-atomic electron interactions was studied. A generalized Hartree-Fock formalism was developed which gives closed expressions for all ordered magnetic states with constant local moments lying on a conical helix. Singlet-triplet pair Green functions were formulated and studied for the s-d exchange model of the dilute magnetic alloys for a single magnetic impurity.
Author (TAB)

**N69-13860#** California Univ., Berkeley. Lawrence Radiation Lab.
**AVERAGE NUCLEAR PROPERTIES**
William Don Myers (Ph.D. Thesis) 1 May 1968 150 p refs
(Contract W-7405-ENG-48)
(UCRL-18214) Avail: CFSTI

A generalized treatment of average nuclear properties is presented. The theory is developed on two levels: First a refinement of the liquid drop model is described. The second level at which average nuclear properties are treated is based on assuming a concrete model of a two-component saturating system, consisting of neutrons and protons interacting by velocity-dependent Yukawa forces. When this model is treated in the Thomas-Fermi approximation a pair of coupled integral equations results, which can be used as the basis of a self-contained model of all average static nuclear properties. A revised estimate is made for the value of the symmetry energy of nuclear matter. Also treated is the question of whether or not neutron matter is bound, and some discussion is given of the spatial distribution, the energy dependence, and the composition dependence to be expected for nuclear optical model potentials on the basis of the statistical methods used.
Author (NSA)

**N69-13861#** Iowa State Univ. of Science and Technology, Ames.
**NUCLEAR SPIN RELAXATION OF HYDROGEN IN THORIUM HYDRIDES**
Jerald Duane Will (Ph.D. Thesis) Aug. 1968 89 p refs
(Contract W-7405-ENG-82)
(IS-T-252) Avail: CFSTI

Hydrogen nuclear spin relaxation in thorium hydride phases has been studied as a function of temperature in the temperature regions where hydrogen diffusion provides the dominant relaxation mechanism. Pulsed nuclear magnetic resonance measurements of the hydrogen spin-lattice and spin-spin relaxation times at a resonance frequency of 10.5 MHz have been interpreted in terms of existing translational diffusion theory in order to extract diffusion parameters and mechanisms. The diffusion mechanism indicated is that of hydrogen jumps between tetrahedral interstitial positions and nearest-neighbor octahedral interstitial positions.
Author (NSA)

**N69-13869#** European Organization for Nuclear Research, Geneva (Switzerland).
**EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH Annual Report, 1967**
1967 183 p refs
(NP-17628) Avail: CFSTI

Developments at CERN in 1967 are outlined. Research and development in nuclear physics, the synchrocyclotron, bubble chambers, theoretical high-energy physics, the proton synchrotron, data handling, and the Intersecting Storage Rings are discussed. Also finance, personnel, and technical services and buildings are reviewed.
NSA

**N69-13874#** Oak Ridge National Lab., Tenn.
**PROTON–PROTON BREMSSTRAHLUNG MEASUREMENTS**
David L. Mason (Ph.D. Thesis—Florida Univ.) Aug. 1968 100 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2275) Avail: CFSTI

Proton–proton bremsstrahlung cross sections were measured for proton energies of 47, 62, and 65 MeV. Although the measurements were not of sufficient accuracy to distinguish between theoretical cross sections calculated using various potentials it appears that the Bryan–Scott potential agrees best with the experimental data. This indicates that a momentum-dependent potential is necessary to describe the nucleon–nucleon interactions.
NSA

**N69-13898#** Rochester Univ., N. Y. Dept. of Physics and Astronomy.
**R-REGION AND OTHER MULTIPION RESONANCES**
T. Ferbel 1 Aug. 1968 55 p refs Presented at the Conf. on Exptl. Meson Spectry., Philadelphia, 27 Apr. 1968
(Contract AT(30-1)-875)
(UR-875-253; CONF-680428-11) Avail: CFSTI

Some new information regarding the $I^0$, B-meson, and the resonances in the R-region is discussed. A few brief remarks are also given concerning the $A_1$.
NSA

# 25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

**N69-12626#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INTERACTION OF CHARGED PARTICLE BEAMS WITH PLASMA (SELECTED ARTICLES)**
28 Mar. 1968 34 p refs Transl. into ENGLISH from the book "Vzaimodeystviye Puchkov Zaryazhennykh Chastits s Plasmoy" Kiev, Naukova Dumka, 1965 p 36–43
(AD-675570; FTD-MT-24-302-67) Avail: CFSTI CSCL 20/9

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1. INVESTIGATION OF PARTICLE ENERGY AND THE CONDITION OF EXCITATION OF LOW FREQUENCY OSCILLATIONS IN PLASMA, FORMED DUE TO THE DEVELOPMENT OF INSTABILITY IN A PLASMA-BEAM SYSTEM Ye. A. Kornilov et al p 1–15 refs (See N69-12627 03-25)

2. TIME CHARACTERISTICS OF HIGH-FREQUENCY OSCILLATIONS DURING THE DEVELOPMENT OF INSTABILITY IN A PLASMA-BEAM SYSTEM Ye. A. Kornilov et al p 16–26 refs (See N69-12628 03-25)

**N69-12627#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INVESTIGATION OF PARTICLE ENERGY AND THE CONDITION OF EXCITATION OF LOW FREQUENCY OSCILLATIONS IN PLASMA, FORMED DUE TO THE DEVELOPMENT OF INSTABILITY IN A PLASMA-BEAM SYSTEM**
Ye. A. Kornilov et al *In its* Interaction of Charged Particle Beams with Plasma 28 Mar. 1968 p 1–15 refs (See N69-12626 03-25)
Avail: CFSTI CSCL 20/9

Ionic flux and energy spectra, and the excitation and spectrum of low frequency oscillations in plasma beam discharges were investigated. A 2 to 5 keV electron beam was used. Results show that during electron beam interaction with the plasma intense low frequency oscillations are observed. High energy ions accompany these oscillations. Investigations of the frequency range of these oscillations and the dependence of the frequency on electron temperature and gas content in the region of the interaction indicate that low frequency oscillations are close to ionic-acoustic. E.C.

N69-12628# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**TIME CHARACTERISTICS OF HIGH-FREQUENCY OSCILLATIONS DURING THE DEVELOPMENT OF INSTABILITY IN A PLASMA-BEAM SYSTEM**
Ye. A. Kornilov et al *In its* Interaction of Charged Particle Beams with Plasma 28 Mar. 1968 p 16-26 refs (See N69-12626 03-25)
Avail: CFSTI CSCL 20/9

Spectral characteristics and time variations of oscillations excited in a plasma by a traversing electron beam are studied. A 4 mm diameter beam (80 mA) was injected into a plasma in a magnetic field (0-2 koe). Beam energy varied from 2 to 5 keV. The beam-plasma interaction region was 40 cm long and the plasma electron density was $10^{12}$ cm$^{-3}$. Variations in the parameters of the experiment led to the effect that when conditions favorable to beam instability growth are established, excitations occur which have maxima at frequencies corresponding to half-integral multiples of electron cyclotron frequencies. The spectrum near the maxima changes periodically during the discharge; the time period of the change is very close to that of the ion-acoustic wave. It is shown that the relative width of the spectrum narrows as the pressure increases and broadens with increases in beam current. At magnetic field intensities higher than critical, the plasma-beam discharge was found to change to a relaxation type of wave excitation. During excitation, the beam current was strongly damped indicating very strong interaction with the plasma. Author

N69-12636 Rensselaer Polytechnic Inst., Troy, N. Y.
**THE EFFECT OF AN AZIMUTHAL MAGNETIC FIELD ON THE HELICAL INSTABILITY IN A HOLLOW POSITIVE COLUMN**
James F. Reynolds (Ph.D. Thesis) 1967 130 p
Avail: Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 68-841

The application of a component of azimuthal magnetic field, $B_\phi$, to a hollow positive column in a strong longitudinal magnetic field is shown to stabilize or destabilize the column against the helical instability depending on the direction in which it is applied. When the resulting magnetic field helix has the same sense as the perturbed density helix, the plasma is destabilized. This is accompanied by a switch to a higher order, $m = 2$, mode and higher frequency of rotation of the helix with increasing $B_\phi$. When the two helices have opposite senses, the plasma is stabilized. In this case, the $m = 1$ is always the dominant mode of the instability. In addition, the confinement of the plasma in the classical regime is improved for this direction of $B_\phi$. A generalized stability theory is derived which predicts the destabilizing and stabilizing effects, the mode switch and the dependence of frequency of rotation of the helix on $B_\phi$. Dissert. Abstr.

N69-12653 Alabama Univ., University.
**SOME SPHERICALLY SYMMETRIC SOLUTIONS OF THE TIME-INDEPENDENT BOLTZMANN-VLASOV EQUATIONS**
Lawrence Hugh Wood (Ph.D. Thesis) 1967 116 p
Avail: Univ. Microfilms: HC $5.80/Microfilm $3.00 Order No. 68-1074

The Boltzmann-Vlasov equations are fundamental to many plasma physics problems and when reduced to the time-independent spherically symmetric form permit detailed analysis of spherical diodes and spherical probes. The principal equation which must be investigated in time-independent situations is the Poisson equation. This thesis presents an improved formalism for calculating the charge density term in Poisson's equation and the current-voltage characteristic of either an electrostatic probe or a plasma diode. The charge density integrals in the Poisson equation contribute nonlinear terms which are implicit functions of the electrostatic potential; accordingly, self-consistent, numerical techniques are necessary to obtain specific results. Several representative diode and probe cases are analyzed and the current-voltage characteristic for a spherical probe in an infinite plasma is presented. Dissert. Abstr.

N69-12719# Uppsala Univ. (Sweden). Inst. of Physics.
**PLASMA OSCILLATIONS IN A CONSTANT ELECTRIC FIELD**
L. Stenflo Jun. 1968 7 p ref
(UUIP-593) Avail: CFSTI

The dispersion relation for longitudinal oscillations was derived for a plasma in a uniform applied electric field. The specific case was that the collision integral could be replaced by a Fokker-Planck term with distinct and energy-dependent relaxation times for momentum and energy. NSA

N69-12750 Colorado State Univ., Fort Collins.
**IONIZATION TIME IN SHOCK HEATED ARGON BY THE LANGMUIR PROBE TECHNIQUE**
William Watson Hill, Jr. (Ph.D. Thesis) 1967 148 p
Avail: Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 68-2600

The behavior of small cylindrical Langmuir probes in plasma generated by a shock wave was investigated, as well as the applicability of the probe for ionization relaxation time measurements. The range of condition was characterized by $7 \leq M \leq 9$ and $20\mu \leq p \leq 2$ mm Hg. Test time limitations restricted effective ionization time information to the Mach number range from 8 to 9 and initial pressures of 1 to 2 mm Hg. Shock conditions were such that the probe was operating in a free molecular flow with respect to the charged particles. The flow bordered on continuum conditions with respect to the neutral atoms. When sufficient time was available, the probe followed the rise of the ionization to equilibrium. Measured relaxation times were in agreement with theoretically predicted values. Equilibrium electron densities predicted by the probe response were just slightly less than the values predicted by the Saha. Dissert. Abstr.

N69-12751# Joint Publications Research Service, Washington, D. C.
**RESEARCH IN TECHNICAL PHYSICS**
26 Nov. 1968 91 p refs Transl. into ENGLISH from Zh. Tekhn. Fiz. (Leningrad), no. 9, 1968 p 1045-1419, 1442-1448, 1465-1471, 1475-1476, 1482-1489, 1521-1528, 1581-1587 (JPRS-46949) Avail: SOD/CFSTI

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3. SOUND WAVE EXCITATION IN A GAS BY CURRENT PULSES Yu. G. Kozlov et al p 33-42 refs (See N69-12754 03-25)

4. MAGNETIC SURFACE DISTORTION IN THE STELLARATION S-1 F. V. Karmanov et al p 43–45 refs (See N69-12755 03-11)

5. AMBIPOLAR DIFFUSION IN THE BOUNDARY LAYER BEHIND A SHOCK WAVE FRONT E. P. Burminskiy et al p 46–57 refs (See N69-12756 03-25)

6. ACCELERATING FIELD OF A LINEAR INDUCTION ACCELERATOR Yu. P. Bakhrushin et al p 58–70 refs (See N69-12757 03-11)

7. ELECTRON SHOCK PHENOMENA ON THE ANODE OF A PULSE X-RAY TUBE K. F. Zelenskiy et al p 72–81 refs (See N69-12758 03-09)

**N69-12752#** Joint Publications Research Service, Washington, D. C.

**HOLOGRAPHIC PLASMA DIAGNOSTICS—A SURVEY**

A. N. Zaydel' et al *In its* Res. in Tech. Phys. 26 Nov. 1968 p 1–22 refs (See N69-12751 03-25)
Avail: SOD/CFSTI

The possibility of using holographic methods for plasma diagnostics was demonstrated in 1966, and some subsequent results of research have been reported. Based on a survey of papers written during 1966–1967, the new possibilities offered by holographic methods are evaluated. The results obtained are also systematized. It should be noted that the basic efforts were aimed at procedural development and not at specific plasma investigations. The results which are described are therefore of illustrative significance. Author

**N69-12753#** Joint Publications Research Service, Washington, D. C.

**PENETRATION OF A LONGITUDINAL ELECTRIC FIELD INTO A SEMICONFINED PLASMA**

V. F. Dryakhlushin et al *In its* Res. in Tech. Phys. 26 Nov. 1968 p 23–32 refs (See N69-12751 03-25)
Avail: SOD/CFSTI

The penetration of a longitudinal electric field into a semiconfined homogeneous plasma with diffuse reflection of the plasma particles from its boundary is investigated in the kinetic approximation. The results obtained are compared with corresponding results where the analogous problem is investigated under the condition of mirror reflection of the plasma particles from the plasma boundary. Comparison shows that the nature of penetration of the longitudinal field into the plasma depends essentially on the specific law of interaction of the plasma particles with the surface only in the low-frequency range ($0 \leq \omega \approx \omega_{0i}$; $\omega_{0i}$ is the Langmuir ion frequency). In the rest of the range this dependence turns out to be insignificant. The causes for this behavior are discussed. Author

**N69-12754#** Joint Publications Research Service, Washington, D. C.

**SOUND WAVE EXCITATION IN A GAS BY CURRENT PULSES**

Yu. G. Kozlov et al *In its* Res. in Tech. Phys. 26 Nov. 1968 p 33–42 refs (See N69-12751 03-25)
Avail: SOD/CFSTI

Data on the conductance of a gas-discharge plasma in the process of its decay during impulsive discharge in inert gases under average pressures (5–15 mm Hg) are presented. Longitudinal and radial sound vibrations excited by a current pulse in various stages of plasma decay were observed. The presence of many types of oscillations whose frequency is related to the temperature, molecular weight of the gas and geometry of the discharge tube was noted. The study of free sound vibrations can turn out to be useful for purposes of low-temperature plasma diagnostics. Author

**N69-12756#** Joint Publications Research Service, Washington, D. C.

**AMBIPOLAR DIFFUSION IN THE BOUNDARY LAYER BEHIND A SHOCK WAVE FRONT**

E. P. Burminskiy et al *In its* Res. in Tech. Phys. 26 Nov. 1968 p 46–57 refs (See N69-12751 03-25)
Avail: SOD/CFSTI

The laminar boundary layer behind the front of strong shock waves is calculated, taking into account the ambipolar diffusion of charged particles. The results of the calculation are compared with an experiment performed on a gas-dynamic shock tube with argon as the process gas at $p_1 = 1$ mm Hg and $M_s = 10$. Author

**N69-12783#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation.

**NONLINEAR GENERATION OF THE PLASMA WAVES BY THE TRANSVERSE WAVE BEAM**

V. G. V. Makhan'kov et al 1968 24 p refs In RUSSIAN
(JINR-P9-3980) Avail: CFSTI

Instability of bunched electromagnetic waves with respect to the excitation of the acoustic vibrations of plasma was investigated. The frequencies of the latter are a lot smaller than the frequency of the particle collisions. It is shown that two types of the acoustic vibrations can be excited. Author (NSA)

**N69-12773** Brown Univ., Providence, R. I.

**DISPERSION AND ABSORPTION OF ELECTROMAGNETIC MODES IN A MAGNETO QUANTUM PLASMA**

Paul Roger Beaudet (Ph.D. Thesis) 1967 169 p
Avail: Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 68-1437

A quantum derivation that takes full account of the diffusion current is given for the magnetoconductivity tensor of an electron gas in the presence of impurities. The dispersion relations for self-sustained electromagnetic modes of a one and two-component plasma propagating at arbitrary angles to the applied magnetic field are obtained. Particular attention is paid to the interaction of the helicon and longitudinal plasma modes. The attenuation of these modes via collision damping, Landau damping, and Döppler-shifted cyclotron resonance damping is derived with emphasis placed on the structure of the giant quantum peaks in the Landau damping of the helicon mode and on the collision broadening of these peaks. Dissert. Abstr.

**N69-12781#** Princeton Univ., N. J. Plasma Physics Lab.

**DAMPING OF A SUPERHIGH-FREQUENCY FIELD IN A PLASMA IN THE PRESENCE OF MAGNETIC FIELDS APPRECIABLY GREATER THAN THE CYCLOTRON FIELD**

V. N. Budnikov et al Jun. 1968 13 p refs Transl. into ENGLISH from a Russian report
(Contract AT(30-1)-1238)
(MATT-Trans-57) Avail: CFSTI

Experiments demonstrated the possibility of effective absorption of superhigh-frequency energy by a plasma in a magnetic field appreciably exceeding the cyclotron field under the conditions of weak influence of collisions. NSA

**N69-12795#** Kernforschungsanlage, Juelich (West Germany). Inst. fuer Plasmaphysik.

**RAPID TIME- AND SPACE RESOLVED MEASUREMENT OF LUMINOUS DENSITY DISTRIBUTIONS**

W. Hopmann Jun. 1968 12 p refs
(JUL-537-PP) Avail: CFSTI

The measurement of luminous density distribution in plasmas by densitometric evaluation of pictures, taken with high-speed image-converter or rotating-mirror cameras, suffers from the

uncertainties in spectral response, sensitivity, and the reciprocity-law failure of photographic emulsions. Using a special line selector switch, selected lines of a single exposure were measured with one oscilloscope. The results of this technique have led to the design of a new compact and versatile system. It consists of the TV camera, the shutter pulse generator, and the recording unit. The latter comprises the multiple-line oscilloscope and a cinescope with a flat-faced picture tube of excellent geometry for recording purposes. The incorporation of an electronic isophote converter is envisaged. By use of image orthicon camera tubes with bialcali photocathodes a shutter efficiency of $10^5$ was achieved, the sensitivity is 45 DIN (≈ 16,000 ASA). The transfer function is linear within a contrast range of 1:25, and the accuracy (5 to 10%) is limited by the beam noise in the tube. Author (NSA)

**N69-12821#** Academy of Sciences (USSR), Leningrad.
**CYCLOTRON HEATING OF PLASMA IONS AND ELECTRONS BY HIGH-FREQUENCY FIELDS**
B. V. Galaktionov, K. M. Novik, K. A. Podushnikova, B. P. Poloskin, and O. N. Shcherbinin [1968] 16 p refs Transl. into ENGLISH from a Russian report
(MATT-TRANS-60) Avail: CFSTI

In this experiment the possibility of creating a plasma with independently regulated energy of the plasma electrons and ions was investigated. Superhigh-frequency power was used to heat the electrons. The technique for exciting an ionic cyclotron wave proposed by Stix was used to heat the ions. NSA

**N69-12851** Wisconsin Univ., Madison.
**AN EXPERIMENTAL INVESTIGATION OF MICROWAVE HARMONIC GENERATION IN A PLASMA**
Jes Asmussen, Jr. (Ph.D. Thesis) 1967 172 p
Avail: Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 67-12407

A study of harmonic generation in a microwave discharge is investigated both theoretically and experimentally. A nonlinear one-dimensional mathematical model is developed. This model, called a plasma capacitor, includes the reactive spatial variation of E nonlinearities which under the proper plasma conditions can generate strong harmonics. Harmonic generation in a number of gases is investigated. Double probe measurements of plasma density and electron temperature substantiate the nonlinear plasma capacitor theory. Additional harmonic resonant behavior in capacitor plate spacing, pressure and power input are explained as Tonks-Dattner harmonics. A new graphical method of analysis, based on experimental fact and pressure-collision frequency-electron energy curves, is presented. This method of analysis yields results that can be used to design and predict the performance of frequency multipliers. Dissert. Abstr.

**N69-12871** Princeton Univ., N. J.
**THEORETICAL STUDIES OF CONTINUUM, WEAKLY IONIZED GAS FLOWS INCLUDING COMPRESSIBILITY AND ELECTRON ENERGY EFFECTS**
Andrew Francis Burke (Ph.D. Thesis) 1967 169 p
Avail: Univ. Microfilms: HC $7.80/Microfilm $3.00 Order No. 68-2463

A general theory for the flow of weakly ionized gases about electrically biased bodies in continuum flow is presented. Particular attention is given to the derivation of mass and energy transport and energy exchange relations for the ionized species which are applicable in a two-temperature plasma, delineation of the various regions by which the flow field can be described, and the role and consequences of various electron energy transfer and exchange processes. Numerical results for the electric field and electron temperature distributions and current-voltage characteristics for simple body shapes are given for a range of Mach number, Reynolds number, surface-temperature and values of the energy-transfer and exchange parameters. Methods of correlating the results are presented which facilitate their application and interpretation in cases other than those calculated. Dissert. Abstr.

**N69-12969** Stanford Univ., Calif.
**NONUNIFORM ELECTRICAL CONDUCTION IN MAGNETOHYDRODYNAMIC CHANNELS**
David Anthony Oliver (Ph.D. Thesis) 1967 184 p
Avail: Univ. Microfilms: HC $8.40/Microfilm $3.00 Order No. 67-17475

Methods of describing steady electrical conduction in a partially ionized gas with Hall effect, strong applied or magnetically induced electric fields, nonuniform electrical conductivity, and nonequipartition electron heating are proposed. The occurrence of nonequipartition heating is shown to lead to the possible development of arbitrarily large conductivity gradients in the gas. Nonequipartition heating is also found to lead to a steady state electrical conduction problem characterized mathematically by a system of partial differential equations of mixed elliptic-hyperbolic type. It has previously been shown that the time dependent form of the electromagnetic and diffusion equations used in the present work predict an ionization instability which occurs with strong Hall effects. The effect of finite rates of ionization and recombination on this ionization instability are examined. Dissert. Abstr.

**N69-12980#** Atomic Energy Commission Research Establishment, Riso (Denmark).
**SIDE-PINCH EFFECT OF A MAGNETICALLY DRIVEN SHOCK TUBE WITH PARALLEL-PLATE ELECTRODES**
C. T. Chang, V. Korsbech, and K. Mondrup Apr. 1968 21 p refs
(Riso-176) Avail: CFSTI

For a study of the possible effect of the side pinch on the steady-state driving current and shock speed of a magnetically driven shock tube with parallel plate electrodes, a semiempirical model is formulated. The time history of the current and the radial and translational motion of the current-carrying region are expressed by three interacting nonlinear equations with five adjustable parameters describing the variation of the electric circuit elements, the geometry of the shock tube and the initial running conditions. The asymptotic behavior of the solutions is discussed analytically. The analysis indicates the existence of a quasi-steady state of the current and an oscillatory motion of the current-carrying plasmoid. With values of the parameters corresponding to our experimental setup, computational results confirm the predictions. When very strong pinches are avoided, the deviation of the current from its steady state (when the pinch effect is absent) in no case amounts to more than 5%. Author (NSA)

**N69-13065#** Stanford Univ., Calif. Inst. for Plasma Research.
**OSCILLATIONS AND TRANSPORT IN THE REFLEX DISCHARGE**
K. I. Thomassen Oct. 1967 18 p refs
(Contract AT(04-3)-326)
(SU-IPR-204) Avail: CFSTI

A cold cathode reflex discharge in a magnetic field is investigated for fields between 100 to 800 gauss at pressures near $10^{-3}$ torr. Instabilities excited by the primary streams of electrons which create the discharge and instabilities at low frequencies excited by the pressure gradient in the presence of the magnetic field are observed. The radial transport of plasma across the field is investigated and the behavior is linked to the amplitude of the observed low frequency fluctuations. Author (NSA)

**N69-13068** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**PLASMA PHYSICS**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 52–72 refs
(See N69-13060 03-34)
(Contract AT(30-1)-1842)
Avail: CFSTI

Research is reported on: (1) radiofrequency absorption in plasmas, (2) bremsstrahlung from a highly turbulent plasma at harmonics of the plasma frequency, and (3) diffusion waves. NSA

**N69-13069** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**PLASMAS AND CONTROLLED NUCLEAR FUSION**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 73–134 refs
(See N69-13060 03-34)
(Grant NSF GK-1165)
Avail: CFSTI

Research is reported on: (1) system C, (2) computer models of the beam-plasma interaction, (3) thin electron beam interactions with ions in a plasma-filled waveguide, (4) alternative stability analyses, (5) dynamics of the plasma boundary, (6) interactions of a spiraling electron beam with a plasma, (7) low-field microwave emission from contactless indium antimonide samples, (8) and hollow-cathode arc plasma. NSA

**N69-13131** Stevens Inst. of Tech., Hoboken, N. J.
**STABILIZATION OF PLASMA IN A THETA PINCH**
Joseph Norwood, Jr. (Ph.D. Thesis) 1967 122 p
Avail: Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 68-1160

A brief history of the development of the theta pinch is given. The various instabilities which beset the theta-pinch plasma are described in some detail and the importance of the role of magnetic field uniformity is demonstrated. Sources of the field nonuniformity are delineated and discussed. These include the collector plate geometry, the nonlinear effect of the plasma, end effects in the coil, discontinuity in gap spacing as the current flows into the coil, and effects due to the alteration in axial current distribution due to skin effect. The various methods for stabilizing the plasma by eliminating field gradients are described and a new method is proposed employing a flux concentrator. The advantages of this method are compared with other techniques which have been used. Results of quantitative measurements of the field uniformity in an exact half-scale model theta pinch are described and discussed. Dissert. Abstr.

**N69-13171#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**EFFECT OF REDISTRIBUTION OF ELECTRONS IN A PLASMA WAVEGUIDE IN A FIELD OF A STRONG ELECTROMAGNETIC WAVE [EFEKT PERERozPODIDU ELEKTRONIV U PLAZMOVOMU KHVYLEVODI V POLI SYI'NOYI ELEKTOROMAHNITNOYI KHVYLI]**
A. M. Fedorchenko *In its* Ukrain. J. of Phys. 27 Sep. 1967 p 1–6 refs (See N69-13170 03-34)
Avail: CFSTI

The method of quasilinear approximation is used to find the second approximation static fields in plasma waveguides. Electron distribution in the plasma waveguide is calculated with the aid of the Poisson equation. Electrons escape from the boundary layer and are redistributed in space in accordance with the formula for a traveling wave and formula for a standing wave. The redistribution effect is stronger when the wave is slower. Thus, with the aid of strong electromagnetic waves, the electron concentration in definite spots can be greatly increased owing to redistribution. Author

**N69-13173*#** Avco-Everett Research Lab., Everett, Mass.
**AN ION RESONANCE INSTABILITY IN GROSSLY NON-NEUTRAL PLASMAS**
R. H. Levy, J. D. Daugherty, and O. Buneman Jul. 1968 57 p refs
(Contracts NAS8-21392; AT(30-1)-3863; AF 49(638)-1553)
(NASA-CR-98157; RR-302) Avail: CFSTI CSCL 20I

The addition of a certain fraction of ions to an otherwise stable cloud of electrons can in certain circumstances result in an instability. The case of a low density ($q = \omega_p^2/\omega_c^2 << 1$) electron cloud in which the electron motions can be described by $\underline{E} + \underline{v}_e \times \underline{B} = 0$ is considered in detail. The condition for onset of the instability is that the unperturbed ion orbits (which characteristically traverse the entire electron cloud) should involve frequencies close to that of the diocotron wave that can propagate on the electron cloud. This condition is equivalent to having the ratio $Zm_e/m_i q$ of the order of unity and is independent of the ion density. When instability is present, the growth rate is of the order of the ion plasma frequency. Author

**N69-13199#** United Kingdom Atomic Energy Authority, Culham (England). Culham Translations Office.
**ABSORPTION OF MICROWAVE POWER BY A PLASMA AT FREQUENCIES BELOW THE ELECTRON CYCLOTRON FREQUENCY**
V. N. Budnikov et al Mar. 1968 9 p refs Transl. into ENGLISH from Russian
(CTO-494; NP-tr-1668) Avail: CFSTI

An experimental measurement was made of the absorption of microwave power in a magnetic field significantly exceeding the cyclotron field. Measurements of the attenuation of the transmitted signal are given as a function of the mean density. NSA

**N69-13212*#** Avco-Everett Research Lab., Everett, Mass.
**EXPERIMENTS ON THE INJECTION AND CONTAINMENT OF ELECTRON CLOUDS IN A TOROIDAL APPARATUS**
J. D. Daugherty, J. E. Eninger, and G. S. Janes Jul. 1968 63 p refs
(Contracts NAS8-21392; AT(30-1)-3863; AF 49(638)-1553)
(NASA-CR-98158; NYO-3863-7; RR-284) Avail: CFSTI CSCL 20I

Injection and containment of un-neutralized clouds of electrons has been accomplished with an azimuthally symmetric, toroidal, magnetic field. The confining magnetic field is produced within a conducting toroidal chamber. The induction of this magnetic field has been used to inject the electron cloud (inductive charging). Average electron densities of $4 \times 10^9$ cm $^{-3}$ and peak electrostatic well depths of $\approx$ 400 kv have been achieved. Semi-empirical correlations are given which show the inductive charging scheme to be governed by an electron energy restriction and finally limited by the occurrence of anomalous crossed field beam noise. Stable equilibria, without the necessity of a rotational transform have been observed for times in excess of 60$\mu$ sec. Correlation of the containment time observations with the predictions of a theoretical model for an ion-diocotron wave instability shows that the containment time is governed by the rate of ionization of the residual neutral gas ($p > 10^{-7}$ torr) in the apparatus. The correlation of theory and experiment appear to confirm the theoretical prediction that significant fractional charge neutralization (in the range of 10% to 20%) can be stably contained. Author

**N69-13267#** Royal Aircraft Establishment, Farnborough (England).
**DESIGN AND TESTING OF A MAGNETIC FIELD COIL ASSEMBLY FOR A PLASMA FACILITY**
M. J. Helyar Mar. 1968 46 p refs
(RAE-TR-68061) Avail: CFSTI

The report first discusses the requirements for a uniform axial magnetic field for use in a proposed experiment on the propagation of ion acoustic waves in a low temperature plasma. Then, the analytical expressions for the axial and radial components of the magnetic field, at any point, of a spiral coil are derived and evaluated for a single coil, and for a 28 coil axial array giving optimum uniformity of field strength in the working region of the facility. The theoretical axial and radial field distributions, on and off the axis, have been checked by means of a travelling Hall probe and found to be in good agreement. Finally, the coil assembly, power supply and cooling system are described. Author (ESRO)

**N69-13318#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**IONIZATIONAL INSTABILITY AND TURBULENT CONDUCTIVITY OF NONEQUILIBRIUM PLASMA [IONIZATSIONNAYA NEUSTOYCHIVOST' I TURBULENTNAYA PROVODIMOST' NERAVANOVESNOY PLAZMY]**

V. N. Belousov *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 44–59 refs (See N69-13314 03-03)
(SM-74/88) Avail: CFSTI

Experimental results are presented obtained in the study of pulse discharges in argon–cesium mixtures held in transverse magnetic fields. The partial pressure of argon was 50 mm of Hg, while that of cesium was $3 \cdot 10^{-2}$ mm of Hg; the maximum value of the product of the Larmor frequency of rotation of electrons by the average collision time of electrons, $\Omega_e \tau_e$, was of the order of 9. It was shown that the observed inhomogeneity of the plasma density when $\Omega_e \tau_e \geq 1$ is due to ionizational instability. Nonisothermal argon–cesium plasma in which the current is passed perpendicularly to the direction of the magnetic field developed ionizational instabilities if the degree of ionization of the added impurity is low. The instability starts in the vicinity of $\Omega_e \tau_e$ 1. There was an ionizational instability in completely ionized argon–cesium plasma with electron density of $5 \cdot 10^{14}$ cm$^{-3}$ and $\Omega_e \tau_e \approx 3$. When $\Omega_e \tau_e \geq 4$ density fluctuations reappear in completely ionized plasma, the nature of these is still unclear. The density fluctuations, which are brought about by ionizational instability, resulted in saturation of the quantity $< E_x >/< E_y >$ at a level of about 2 to 3. The effective conductivity of plasma perpendicular to the magnetic field was inversely proportional to $\Omega_e \tau_e$. Author

**N69-13320#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**AN EXPERIMENTAL INVESTIGATION OF MAGNETOHYDRODYNAMIC FLOW OF LIQUID METAL IN A RECTANGULAR CHANNEL WITH CONDUCTING WALLS [EKSPERIMENTAL'NOYE ISSLEDOVANIYE MAGNITOGIDRODINAMICHESKOGO TECHNIYA ZHIDKOGO METALLA V PRYAMOUGOL'NOM KANALE S PROVODYASHCHIMI STENKAMI]**

K. I. Dmitriev et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generations 14 Nov. 1968 p 69–80 refs (See N69-13314 03-03)
(SM-74/93) Avail: CFSTI

The magnetohydrodynamic flow was examined of a conducting liquid in a rectangular channel of an MHD generator with conducting walls, at liquid metal velocity up to 30 m/sec. The dependence of the pressure drop on the flow parameters is analyzed in a long channal without a load. The contribution of the magnetohydrodynamic loss and of the loss in the walls to the total loss is determined. The efficiency of conversion of kinetic energy into electrical energy for different flow parameters is investigated in a small channel. In channels with conducting walls the pressure drop cannot be considered as a simple sum of the losses in the walls and the magnetohydraulic losses. In making computations for channels by means of the formula for magnetohydraulic drag in the channal, it is necessary to keep in mind the rapid increase in $\lambda_{eff}$ with $M^2/Re$. Subsequent experiments will indicate how universal this dependance is in channels with different ratios of the sides. In generators having channels with conducting walls of reasonable thickness, the obtained efficiency of conversion of kinetic energy into electrical energy is of the order of 50%. Author

**N69-13321#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**THE EFFECTIVE CONDUCTIVITY OF A PLASMA IN A STRONG MAGNETIC FIELD [EFFEKTIVNAYA PROVODIMOST PLAZMY V SIL'NOM MAGNITNOM POLE]**

A. A. Vedenev et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 81–90 refs (See N69-13314 03-03)
(SM-74/94) Avail: CFSTI

Given an inhomogeneous plasma in a magnetic field, the following model is used for evaluating its effective conductivity: It is assumed that the plasma is stratified and strongly anisotropic, with the dimensions of the strata along the x axis considerably less than the widths along the y axis. In this case, in determining the effective transverse (with respect to the magnetic field) conductivity, the equations can be averaged first along the x coordinate and then along the y coordinate. Author

**N69-13322#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**THE VELOCITY OF IONIZATION WAVES IN A LOW TEMPERATURE PLASMA [SKOROST IONIZATSIONNYKH VOLNV NIZKOTEMPERATURNOY PLAZME]**

A. V. Nedospasov *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 91–96 refs (See N69-13314 03-03)
(SM-74/97) Avail: CFSTI

The problem of the velocity of the ionization waves in a weakly ionized plasma was investigated. The dependence obtained for the velocity of ionization waves is confirmed by the experimental data reported in the literature. An exception occurs in the case for which no experimental verification known exists. Author

**N69-13324#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**STUDY OF THE NONEQUILIBRIUM CONDUCTIVITY OF A PLASMA IN AN MHD GENERATOR [ISSLEDOVANIYE NERAVNVESNOY PROVODIMOSTI PLASMA V MAGNITOGAZODINAMICHESKOM GENERATOR]**

M. I. Afanas'yev et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 113–119 refs (See N69-13314 03-03)
(SM-74/104) Avail: CFSTI

Under certain physical conditions the temperature of plasma electrons may be considerably higher than that of the ions and neutral particles. Such a state of thermodynamic nonequilibrium may be produced in the duct of an MHD generator by heating the electrons with the aid of an electric field induced by the plasma flowing transversly through a magnetic field. This leads to a considerable increase in the electrical conductivity of the plasma and in the power density of the MHD generator. Experiments were carried out on an MHD generator model. The inert gas was heated by means of dc plasmatrons. Measured amounts of an alkali metal were added in the liquid phase to the gas up to the point when the latter passed through the arc discharge region. From the intermediate chamber the low-temperature plasma passed into the accelerating nozzle and then entered the linear MHD duct. Continuous and segmented electrodes were used in the MHD duct. The static pressure in the duct was 1 atm abs or higher. The velocity of the working fluid varied in both the subsonic and the

supersonic regions. The gas temperature varied over a wide range. The different physical characteristics of the plasma were measured simultaneously by spectroscopic, aero-dynamic and electrical methods. Author

**N69-13326#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**VARIATION OF THE ELECTRICAL CONDUCTIVITY OF VAPOR-LIQUID POTASSIUM MIXTURES [IZMERENIYE ELEKTROPROVODNOSTI PAROZHIDKOSTNOY SMESI KALIYA]**

P. L. Kirilov et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 132–141 refs (See N69-13314 03-03)
(SM-74/106) Avail: CFSTI

The variation of electrical conductivity in vapor-liquid potassium mixtures is studied, concluding that, with a reduction in the temperature, the electron emission drops off exponentially and the drops start to absorb electrons, thus bringing about a reduction in the electrical conductivity. Hence the effect of electron emission from the drops should be highly dependent on the temperature. Further experiments are needed to more clearly establish the causes of electrical conductivity of unsaturated vapor. Author

**N69-13328#** Air Force Systems Command, Wright-Patterson AFB, Ohio.

**ELECTROMAGNETIC PHENOMENA IN A DENSE PLASMA WITH NONEQUILIBRIUM CONDUCTIVITY IN A VARIABLE MAGNETIC FIELD [ELEKTROMAGNITNYYE YAVLENIYA V PLOTNOY PLAZME S NERAVNOVESNOY ELEKTROPROVODNOST'YU V PEREMENNOM MAGNITNOM POLE]**

K. I. Kim *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 155–161 refs (See N69-13314 03-03)
(SM-74/202) Avail: CFSTI

The electromagnetic phenomena occurring in a dense plasma of electrical conductivity $\sigma = C\,\overline{|}\,\phi$ moving in a traveling-wave type magnetic field were investigated. It is assumed that the parameters of the plasma and the ranges of variation of the individual quantities (J, $T_e$, etc.) are such that the function $\sigma = C\,\overline{|}\,\phi$ applies. The plasma was treated as an ideal incompressible fluid. This last condition, as well as allowing for the presence of a static pressure gradient and of ponderomotive forces which act only in the direction of motion of the plasma, permits the derivation of the plasma equations directly from the equations of electrodynamics. Author

**N69-13330#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**BOUNDARY LAYERS IN A TWO-TEMPERATURE PLASMA [O POGRANICHNYKH SLOYAKH V DVUTEMPERATURNOY PLAZME]**

V. V. Gogosov *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 174–187 refs (See N69-13314 03-03)
(SM-74/205) Avail: CFSTI

The boundary layer equations for a two temperature plasma are derived. It is shown that in a two temperature plasma, for the study of temperature increase near the walls, it is generally necessary to consider the two boundary layers: the electron layer (in which there is a sharp change in electron temperature) and the ion layer (in which there is a sharp change in the ion temperature for a fully ionized plasma and in the ion and the ion and the neutral temperature for a partially ionized plasma). The equations for the temperatures in the electron and the ion boundary layers are written out. It is established that in a fully ionized plasma the thickness of the electron-temperature boundary layer is much greater than the thickness of the ion-temperature boundary layer. In a partially ionized plasma the thickness of the electron-temperature boundary layer can be much smaller than the thickness of the temperature boundary layer for the neutrals. Cases are pointed out in which the electron-temperature boundary layer is absent. Author

**N69-13337#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**A CONTRIBUTION TO THE THEORY OF ACOUSTIC STABILITY OF AN INHOMOGENEOUS WEAKLY IONIZED PLASMA [K TEORII USTOICHIVOSTI ZVUKA V NEODNORODNOY SLABOIONIZOVANNOY PLASME]**

S. A. Trigav *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 258–263 refs (See N69-13314 03-03)
(SM-74/223) Avail: CFSTI

The oscillations in a weakly ionized plasma were examined where in the normal state a current is flowing perpendicular to the external magnetic field. In particular, it was found that in the region of flow velocities larger than the sound velocity, acoustic oscillations may build up and propagate perpendicular to the magnetic field at obtuse angles to the current direction. The growth of these oscillations is proportional to the density of the current flowing in the plasma and consequently, by virture of the equations for the normal state, to the pressure gradient in the plasma. Since the equations describing normal state of the plasma cannot have a homogeneous solution and the growth of the acoustic oscillations is connected just with the nonuniformity of the plasma in the normal state, a systematic consideration of this inhomogeneity appears advisable. For a one dimensional inhomogeneous system a differential equation is obtained which describes the propagation of the oscillations perpendicular to the magnetic field. This equation is analyzed in the geometrical optics approximation. Author

**N69-13339#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**PLASMA FLOW IN THE DUCT OF A "SERIES" MHD GENERATOR [O TECHENII PLAZMY V KANALA SERIYESNOGO MGD GENERATORA]**

V. I. Kovbasyuk et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 272–279 refs (See N69-13314 03-03)
(SM-74/225) Avail: CFSTI

For Hall numbers comparable to unity, a series MHD generator has an advantage over Faraday, segmented, or Hall type MHD generators, since it admits of a high degree of electrode segmenting for a limiting number of different loads and gives a high conversion efficiency. The plasma flow in the generator duct has a number of special characteristics, determined by the changes in the physical properties of the working fluid along the duct and by changes in the local load factor for a given electrode configuration. A study is made of plasma movement in the duct of a series MHD generator. A general statement of the problem is formulated and conditions are determined for the validity of a quasi one dimensional flow model. Flow conditions close to the optimum are calculated and analyzed. Using a graphical analysis method a simple interpretation is given for the results obtained. Author

**N69-13348#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**AN EXPERIMENTAL INVESTIGATION OF THE ELECTRICAL CONDUCTIVITY OF PLASMA IN AN MHD GENERATOR MODEL [EKSPERIMENTAL'NOYE**

**ISSLEDOVANIYE ELEKTROPROVODNOSTI PLAZMY NA MODELI MGDG]**

N. M. Maslennikov et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators. 14 Nov. 1968 p 338–347 refs (See N69-13314 03-03)
(SM-74/236) Avail: CFSTI

At a gas temperature of 1300°K in the induced field, the experimentally measured electrical conductivity is 450 times greater than the equilibrium value of 0.068 mho/cm. Production of nonequilibrium electrical conductivity requires first of all that the proper density of the emission current from the cathode be provided in order to decrease the voltage drop in the layer around the cathode. Further increase in electrical conductivity is limited by the anode voltage drop. Higest possible increase in electrical conductivity requires that the optimum electrode length be selected. The relaxation of the electron temperature from the equilibrium value to the nonequilibrium value occurs over a short distance of the order of 0.3 cm. Author

**N69-13347#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ELECTRICAL ARCS IN IONIZED AND NON-IONIZED GAS STREAMS [ELEKTRICHESKAYA DUGA V POTOKE IONIZOVANNOGO I NEIONIZOVANNOGO]**

V. Yu. Baranov et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 348–359 refs (See N69-13314 03-03)
(SM-74/238) Avail: CFSTI

The experiments cited have shown that at small flow velocities the electric arc in the preionized gas can ensure sufficiently uniform ionization of the flow in the range of pressures which are of interest from the point of view of MHD generators. At velocities $\approx 10^5$ cm/sec an isolated transverse arc must burn in the breakdown regime and plasma from such a preionizer arrives in bunches. Although in principle conversion of electrical energy is possible with strongly modulated conductivity, this conversion is less efficient than in the case of uniform and sufficiently high conductivity. Author

**N69-13425#** Aeronautical Research Council (Gt. Brit.)

**THE INFLUENCE OF GAS STREAMS AND MAGNETIC FIELDS ON ELECTRIC DISCHARGES. PART 5: ARCS AT PRESSURES UP TO 18 ATMOSPHERES IN ANNULAR GAPS**

V. W. Adams 1968 22 p refs Supersedes RAE-TR-67089; ARC-29311; See N68-12969
(ARC-CP-988; RAE-TR-67089; ARC-29311) Avail: CFSTI

Experimental results are presented for electric arcs rotating round an annular gap between carbon electrodes in a pressure vessel with a throughput of nitrogen. The arc velocity, U, is shown to depend on the ambient pressure, P, in the following way, i.e., $U \propto p^{-0.44}$, for pressures up to 18 atmospheres. Some results for arcs rotating in an annular gap at atmospheric pressure with additional air flows through the gap are also given. In this case water-cooled brass electrodes are used. The rotational arc velocity is shown to be reduced by small flows to about 1/2 the value with no flow. Initial difficulties at high pressure and the effects of small axial flows are regarded as significant for arc heaters and are described in some detail. Author (ESRO)

**N69-13430#** Aeronautical Research Council (Gt. Brit.)

**CORRELATION OF VOLTAGE-CURRENT CHARACTERISTICS OF WALL-STABILIZED, FREE-BURNING AND CROSS-FLOW ARCS**

W. T. Lord 1968 29 p refs Supersedes RAE-TR-67087; ARC-29326; See N68-12803
(ARC-CP-996; RAE-TR-67087; ARC-29326) Avail: CFSTI

A comparison is made between non-dimensional forms of the voltage-current characteristics of wall-stabilised, free-burning and cross-flow arcs. Effects of representative length-scale, external heat transfer, the relation between electric conductivity and heat-flux potential, and radiation are displayed. Author (ESRO)

**N69-13437#** Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics.

**A STUDY OF THE DYNAMIC INTERACTION OF A PLASMOID WITH A MAGNETOSTATIC FIELD GRADIENT FROM AN AXIAL CURRENT, VOLUME 3 Interim Technical Report**

Ashok Deshmukh and Winston H. Bostick Feb. 1968 96 p refs (Grant AF-AFOSR-485-67)
(AD-676666; SIT-P222; AFOSR-68-1670; ITR-1-VOL-3) Avail: CFSTI CSCL 20/9

The dynamic behavior of a plasmoid in a magnetostatic field having a gradient is investigated. The plasmoid is produced by a Bostick type twin electrode button source and the azimuthally symmetric magnetostatic field with a $1/r$ dependence is produced by an axial current of up to 48 kA. The motion of such a plasmoid, projected in the transverse-to-B plane and in the direction of increasing field, is studied. The experimental observations reveal that in the transverse plane the plasmoid penetrates across the field lines while experiencing radial deceleration in its bulk (fluid) velocity, and a drift along the axial direction. The radial component of the fluid velocity of this plasma eventually reduces to zero at a turning point; the plasmoid then reverses its radial direction of motion and travels away from the axial current. Concurrently, the plasma spreads along the azimuthal field lines and drifts axially in the direction opposite to that of the axial drift of the plasma in the transverse plane. This plasma also forms a plasma-field interface cavity surrounding the axial current, and its boundary lies at the radial position of the turning point of the trajectory of the plasma in the transverse plane. Author (TAB)

**N69-13462#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**INVESTIGATION OF AN ELECTRICAL DISCHARGE SUPPORTED BY A LORENTZ FORCE [ISSLEDOVANIE ELEKTRICHESKOGO RAZRYADA, PODDERZHIVAEMOGO SILOI LORENTSA]**

A. F. Vitshas and V. S. Golubev Oct. 1967 33 p refs Transl. into ENGLISH of the Russian Report 1967 p 1–24
(AD-676541; FTD-MT-24-206-67; IAE-1328) Avail: CFSTI CSCL 20/9

There are given results of experiments with a flow of argon with an addition of cesium across a magnetic field in a disc channel, at the entrance of which there was produced preliminary ionization of cesium by means of an electric discharge. It is shown that in the volume of the disk channel there existed an annular electric discharge maintained by the azimuthal Lorentz force. Author (TAB)

**N69-13466#** Sandia Corp., Albuquerque, N. Mex.

**INITIAL RESULTS FROM A TWO-DIMENSIONAL AX-WENDROFF HYDROMAGNETIC CODE**

J. R. Freeman and F. O. Lane, Jr. Aug. 1968 16 p refs Presented at Plasma Simulation Conf., Los Alamos, N. Mex.
(Contract AT(29-1)-789)
(SC-DC-68-2404; CONF-680914-1) Avail: CFSTI

The success of a number of one-dimensional hydromagnetic codes in predicting the gross dynamical behavior of a variety of plasma devices has led to an attempt to extend the calculations to two dimensions. An explicit Eulerian difference scheme of the

Lax–Wendroff variety was chosen to provide a reasonable level of accuracy for a relatively coarse space–time net. A staggered array with provision for fixed regions of fine zoning was used. Numerical stability was achieved by using a third-order smoothing technique reported recently by Lapidus. All calculations assumed currents which were directed solely in the theta direction. A simple two-dimensional high-density theta pinch, incorporating a mirror field at the ends, was chosen as a test example. The hydromagnetic equations included the effects of thermal conduction and a temperature-dependent electrical conductivity. Separate ion and electron temperatures were calculated. Computed results for this example are shown. Author (NSA)

**N69-13498#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

**A TWO-DIMENSIONAL ANALYSIS OF THE MULTIPLE SCATTERING OF AN ELECTON BEAM INJECTED INTO A QUIESCENT COLD PLASMA**

C. T. Case, R. P. Couch, and E. L. Battle [1968] 29 p refs

(AD-676644; AFIT-TR-68-10) Avail: CFSTI CSCL 20/9

The Boltzmann equation can and is being used as the starting point in the description of a number of interesting problems in plasma physics. The basic difficulty is the proper formulation of the collision term in this equation. By using a two-dimensional approach to reduce the mathematical complexity one can see the close relationship between the various methods which have evolved for handling this collision term. It is traditional to assume small-angle deflections in order to reduce the mathematical complexity, and because such an assumption closely approximates true physical conditions in most plasma problems of interest. Author (TAB)

**N69-13567#** Aerospace Corp., El Segundo, Calif. Lab. Operations.

**FUNDAMENTAL APPROACH TO HIGH FREQUENCY BREAKDOWN OF GASES**

M. Epstein and C. J. Lenander Jul. 1968 25 p refs

(Contract F04695-67-C-0158)

(AD-676262; TR-0158(3240-20)-15; SAMSO-TR-68-359) Avail: CFSTI CSCL 20/9

An evaluation was made of the net ionization frequencies of air inferred from breakdown measurements. This was accomplished by comparison of such data with the corresponding values obtained from numerical solutions of the Boltzmann equation. Good agreement is found at high pressures, but the comparison deteriorates with decreasing pressure. This trend is attributed to the use of the effective field concept and the absence of nonuniform field corrections in the processing of the experimental data. Calculations are presented that show that breakdown fields calculated with data obtained from solutions of the Boltzmann equation and combined with an appropriate nonuniform field analysis are in good agreement with experimentally measured breakdown fields. It is concluded that the latter approach provides a more rational and accurate method for predicting high frequency breakdown than previously available methods. Author (TAB)

**N69-13652#** Texas Univ., Austin. Electronics Research Center.

**AN EXPERIMENTAL INVESTIGATION OF THE ION-ION HYBRID RESONANCE**

Albert W. Baird, III and Donald G. Swanson 1 Aug. 1968 59 p refs

(Contract DA-44-009-AMC-1405(T); Grant AF-AFOSR-766-67)

(AD-676277; AFOSR-68-1660; TR-64) Avail: CFSTI CSCL 20/9

An experiment is described in which the ion-ion hybrid resonance is observed and studied. The theory of a cool, partially ionized plasma in a magnetic field is given, and dispersion characteristics of a wave launched in a bounded two-ion species plasma near the resonance is investigated. Computer results showing the behavior of the attenuation coefficient of the launched wave as a function of density, magnetic field, resistivity, density ratio of the ions, and frequency are given. The apparatus is described. The attenuation coefficient has been measured for a variety of plasma conditions; this data has been fitted to the predicted theory with generally good agreement. Author (TAB)

**N69-13655#** Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Electrophysics.

**TRANSIENT EXCITATION OF BOUNDED COLD MAGNETO-PLASMA**

Gerald Whitman Jun. 1968 121 p refs

(Contract F19628-68-C-0072)

(AD-676652; PIBEP-68-001; AFCRL-68-0348) Avail: CFSTI CSCL 20/14

The report examines how a temporally dispersive bounded anisotropic medium affects the propagation of electromagnetic waves due to spatially confined transient excitation. The medium is taken to be a cold plasma bounded by a perfectly conducting plane and subjected to an externally applied z-directed d.c. magnetic field parallel to the plane. The excitation is that of a magnetic line source imbedded in the plasma and directed parallel to the d.c. magnetic field. This source configuration has been chosen because it is capable of exciting surface waves along the boundary. Exact expressions and asymptotic approximations for the direct, reflected, and surface wave magnetic fields at a distant observation point are presented for arbitrary observation times. Emphasis is placed on approximate graphical considerations for the determination of the transient field and also on a physical interpretation of various phenomena. Detailed numerical calculations have been made for various parameter ranges and serve to verify conclusions reached by the graphical procedure. The results obtained highlight transient processes excited by a localized source in a bounded anisotropic environment, and in particular the nature of surface wave propagation under transient conditions. Author (TAB)

**N69-13656#** Avco Corp., Wilmington, Mass. Space Systems Div.

**RADIATION STUDIES OF ARC HEATED NITROGEN, OXYGEN, AND ARGON PLASMAS Final Technical Report, 1 Jun. 1965–15 Jun. 1967**

J. C. Morris, R. W. Krey, and R. L. Garrison Wright-Patterson AFB, Ohio ARL May 1968 214 p refs

(Contract AF 33(615)-2976)

(AD-676651; ARL-68-0103) Avail: CFSTI CSCL 20/9

This report presents continuum radiation and line radiation measurements for nitrogen, oxygen, and argon covering wavelength ranges from the vacuum ultraviolet to the infrared for a selection of pressures and temperatures. A mechanically constricted dc arc was used as the radiation source. Nitrogen continuum data at 1 and 2 atmospheres is reported for wavelengths from 700 to 37,000 A and temperatures from 9,000 to 13,500 K. The spectral data have been treated analytically to separate the radiation from electron-neutral atom and electron-positive ion collisions, and comparison is made with the theory of Burgess and Seaton for the positive ion recombination radiation. Values of the ratio, R, by which this theory differs from our experimental results are given as a function of wavelength. A subtraction of the positive ion radiation from the total continuum yields the contribution from the neutral atom, from which was extracted the approximate absorption edges of the nitrogen negative ion and an estimate of the photo-detachment cross section. Earlier data reported for the argon continuum at atmospheric pressure has been improved by a reinterpretation of the temperature measurement. New argon continuum intensities at 5 atmospheres pressure and 12,300 K are reported. Author (TAB)

N69-13664# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
**SELECTIVE EXCITATION SPECTROSCOPY Final Report, 1 Jun. 1967–31 Jul. 1968**
R. M. Measures Oct. 1968 9 p refs
(Grant AF-AFOSR-944-66)
(AD-676658; AFOSR-68-1922) Avail: CFSTI CSCL 20/9

A new approach to the attainment of localized information has been proposed and is currently being studied. This technique, which is referred to as selective excitation spectroscopy, involves selective optical pumping of a specific atomic transition. The main advantages of this approach compared to Thomson scattering are that lower density plasmas could be studied with less perturbation and with minimal discrimination required against scattered laser radiation. Author (TAB)

N69-13667# Atomic Energy Commission Research Establishment, Riso (Denmark).
**ON THE VISCOSITY AND HEAT CONDUCTIVITY OF A COLLISIONLESS PLASMA IN A MAGNETIC FIELD**
V. P. Milantiev Mar. 1968 20 p refs
(RISO-175) Avail: CFSTI

The viscous stress tensor and the heat flux tensor of a collisionless plasma immersed in a strong magnetic field are calculated by Grad's moments method. No contradiction is found between the expressions of the viscous stress tensor obtained earlier by A. Macmahon and by A. Simon and W. Thompson. It is shown that in the approximation considered the "longitudinal" heat flux is absent. Author (NSA)

N69-13670# Joint Publications Research Service, Washington, D. C.
**IONOSPHERIC MHD GENERATOR**
P. Poletavkin 25 Nov. 1968 19 p Transl. into ENGLISH from Nauka i Zhizn' (Moscow), no. 9, 1968 p 34-40
(JPRS-46941) Avail: SOD/CFSTI

A method of producing electric power is proposed based on the use of solar radiation, thereby making it possible to maintain the equilibrium between the energy radiated by the earth and the energy received from the sun. The operating principles of a magnetohydrodynamic (MHD) generator are discussed to show that the occurrence of an electric current in ionospheric plasma is similar to the action of a MHD generator. Ways of utilizing this solar energy by means of an ionospheric MHD generator are assessed, and the view is offered that this generator is a natural electrical machine having a constant electrical current with a strength of about a million volts. M.G.J.

N69-13702# Nogoya Univ. (Japan). Inst. of Plasma Physics.
**CHARACTERISTICS OF MICROINSTABILITIES IN A HOT ELECTRON PLASMA**
H. Ikegami, H. Ikezi, T. Kawamura, H. Momoto, K. Takayama et al Oct. 1968 20 p refs Presented at 3d Conf. on Plasma Phys. and Controlled Nucl. Fusion Res., Novosibirsk, U.S.S.R., Aug. 1968
(IPPJ-73) Avail: CFSTI

The 150 keV hot-electron plasma was produced in a mirror by pulsed high-power microwaves. Plasma densities of $10^{12}$ electrons/cm$^3$ were observed. During the stable afterglow, an instability was triggered artificially by irradiation of a small microwave pulse. This instability was characterized by a sudden disappearance of the hot electrons and the strong burst of microwaves. The instability was identified as electron cyclotron instability both experimentally and theoretically. The rapid plasma loss was also interpreted by the diffusion of particles in velocity space due to the microinstability. Author

N69-13712# Harry Diamond Labs., Washington, D. C.
**MERCURY ARC PLASMA TUBE DIAGNOSTIC STUDY. PART 2: MICROWAVE PROBE STUDY**
John A. Rosado Aug. 1968 25 p refs
(AD-676823; HDL-TR-1405) Avail: CFSTI CSCL 20/9

This report presents the results of a microwave diagnostic study performed on a mercury arc plasma tube. Utilizing a microwave reflection technique, the electron density in the tube was calibrated as a function of the arc current. Comparison of the results with Langmuir probe measurements previously reported shows good agreement. An outline of the theory pertaining to this study is also included. Author (TAB)

N69-13720# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation.
**NONLINEAR DRIFT INSTABILITY IN TURBULENT PLASMA**
E. N. Krivorutskii, V. G. Makhan'kov, and V. N. Tsytovich 1968 8 p refs In RUSSIAN
(JINR-P9-3981) Avail: CFSTI

It is shown that high-frequency plasma turbulence imposes a significant influence on the spectrum and buildup (damping) of drift oscillations. It is emphasized that even at very weak high-frequency amplitudes $W/n_0T_e << 1$, a considerable change in spectrum drift oscillations could be expected. NSA

N69-13737# Sydney Univ. (Australia). School of Physics.
**HYDROGEN PLASMA DECAY MEASURED BY DOUBLE MICROWAVE INTERFEROMETER**
G. F. Brand Jun. 1968 8 p refs
(NP-17620; ER-39) Avail: CFSTI

A 120-Gc microwave interferometer was used in a double interferometer which can probe a region of plasma at two frequencies simultaneously (the other at 35 Gc). Peak electron densities from $10^{12}$ to $1.8 \times 10^{14}$ cm$^{-3}$ have been measured and compared with spectroscopic measurements. The interferometer is briefly described. NSA

N69-13772# Harry Diamond Labs., Washington, D. C.
**APPROXIMATE METHOD FOR COMPUTING THE PROPAGATION CHARACTERISTICS OF A PLASMA TEST SECTION**
F. J. Tischer Aug. 1968 18 p refs
(AD-676824; HDL-TR-1410) Avail: CFSTI CSCL 20/9

An approximate computation method is described by which the characteristics of a plasma test section can be computed. By this method, the openings in the side walls of the main waveguide caused by the flow channel can be taken into account. The channel, intersecting the main guide at a right angle, is replaced hypothetically by a section of waveguide with slightly increased width, which causes corresponding reflections. Relationships for the equivalent width, for the corrected values of the propagation constant, reflection coefficient, and transmission coefficient are derived. Procedures for the application of the derived equations for the determination of the plasma data from measured values of the reflection and transmission coefficients are outlined. Author (TAB)

N69-13762# Avco-Everett Research Lab., Everett, Mass.
**THE ROLE OF LANDAU DAMPING IN CROSSED-FIELD ELECTRON BEAMS AND INVISCID SHEAR FLOW**
R. J. Briggs, J. D. Daugherty, and R. H. Levy Sep. 1968 72 p refs
(Contract AT(30-1)-3863)
(NYO-3863-9; REPT-317) Avail: CFSTI

Under certain circumstances the problem of the stability of low density crossed field electron beams is precisely analogous to the problem of the stability of incompressible inviscid shear flows. The electron density, the drift velocity, and the potential correspond to the fluid vorticity, velocity, and the stream function respectively. The analogy is valid only for waves propagating in the direction of the unperturbed velocity. Neutrally stable normal modes of oscillation that are found when certain suitable stepfunction unperturbed electron density (vorticity) profiles are assumed seem to disappear when small gradients are present. In the context of a Laplace transform solution of the initial value problem, the vanishing normal modes can be found by analytic continuation of the solution onto another sheet of the cut complex $\omega$ plane. The recovered modes are found to be damped by a fluid wave resonant interaction which closely resembles the Landau damping of plasma oscillations in warm plasmas by particle-wave resonance.
Author (NSA)

**N69-13784#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation.
**NONLINEAR INSTABILITIES OF LANGMUIR WAVES IN THE REGION OF FREQUENT COULOMB COLLISIONS**
V. G. Makhan'kov, V. N. Tsytovich, and B. G. Shchinov 1968 17 p refs In RUSSIAN
(JINR-P9-3979) Avail: CFSTI

Effects of pair Coulomb interactions on linear effects in a completely ionized plasma were investigated. Data obtained show that in the examined area variation of the spectral transfer is possible under the conditions of kinetic nonlinear instability even for not very intense Langmuir oscillations. The qualitative character of nonlinear hydrodynamic instability of narrow intense Langmuir packets is discussed.
Author (NSA)

**N69-13794#** Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics.
**THE INTERACTION OF PLASMOIDS WITH MAGNETIC FIELDS, VOLUME 2 Interim Technical Report**
Joseph Zorskie and Wilston H. Bostick Feb. 1968 124 p refs
(Grant AF-AFOSR-465-67)
(AD-676664; AFOSR-68-1669; SIT-P221; ITR-1-VOL-2) Avail: CFSTI CSCL 20/9

Plasma from small button-type sources are investigated. The temperature, velocity peak density and total mass are determined. The mechanisms of production of this plasma are discussed. The plasma is directed transversely across homogeneous magnetic fields and the subsequent interaction is studied. The movement and configuration of the plasma both across and along the field lines, and the dependence on plasma ion mass and magnetic field strength are determined. Internal plasma structure is probed and internal plasma motion (rigid motion) is confirmed. Theoretical work on plasma vortices is reviewed and compared to the experiment. Evidence from a Plasma Camera is presented which indicates a preferred direction for the growth of plasma protuberances.
Author (TAB)

**N69-13800#** Los Alamos Scientific Lab., N. Mex.
**CHARACTERISTICS OF THE SCYLLACITA THETA PINCH**
D. B. Thomson, R. S. Caird, K. J. Ewing, V. A. Finlayson, C. M. Fowler et al Apr. 1968 31 p refs
(Contract W-7405-eng-36)
(LA-3863) Avail: CFSTI

Scyllacita is a small high-voltage $\theta$-pinch developed for application to experiments with explosive magnetic compression. Results of laboratory studies are given of the dependence of the first half-cycle neutron yield on pressure, reverse field, preionization, bank voltage, number of capacitors, and warmup. Best laboratory yields averaged $2 \times 10^5$ neutrons on first half cycle obtained at 60 to 100 microns deuterium with a bias of $-1.4$ kG. Reliability was sensitive to spark gap electrode spacings, which determine capacitor discharge simultaneity. A peak field of 55 kG, 12-$\mu$sec period, was obtained in an 8-cm-diameter coil, 24 cm long. A side-fed coil explosive implosion system was developed, which increased the initial Scyllacita field to about 250 kG in 5 $\mu$sec as the implosion progressed. Scyllacita was moved to the firing point, tested, and used with this implosion system for an explosive shot which gave a yield of about $5 \times 10^9$ neutrons.
Author (NSA)

**N69-13833#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INVESTIGATION OF CURRENT DISTRIBUTION IN A COAXIAL PLASMA GUN [ISSLEDOVANIE RASPREDELENIYA TOKA V KOAKSIALNOI PLAZMENNOI PUSHKE]**
I. M. Zolototrubov, V. A. Kiselev, and Yu. M. Novikov 8 Sep. 1967 13 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Ukr. RSR, Fiz.-Tekhn. Inst. (Kiev), no. 82, 1964 p 1–10
(AD-676535; FTD-HT-23-584-67) Avail: CFSTI CSCL 20/9

Current distribution along the length of coaxial plasma guns was studied using differential magnetic probes and high speed photography. It is shown that several current sheets are initially formed during the discharge in the plasma gun. The discharge current of the capacitor bank leads to fusion of the current sheets during its later stage. Current sheet motion was also studied using magnetic probes and high speed photography. A comparison of plasmoid and current sheet speeds indicates that these are not identical and in fact plasmoid motion exceeds the sheet motion by a factor of about seven. Plasmoid acceleration is not a result of electrodynamic acceleration but rather is due to the drift of plasma in the crossed magnetic and electric fields existing in the plasma gun ahead of the current sheet. This is consistent with the magnitude of the Larmour radius, which turns out to be comparable to the plasma gun diameter.
TAB

**N69-13846#** Institut fur Plasmaphysik G.m.b.H., Garching (West Germany).
**ON THE EVALUATION OF THE WENDELSTEIN EXPERIMENTS**
G. von Gierke, G. Grieger, and K. U. von Hagenow Jul. 1968 49 p refs
(IPP-2/70) Avail: CFSTI

The earlier evaluations of the experiments performed in 1965 in the Wendelstein stellarator W Ib have been revised. In particular, later probe calibrations, the shape of the magnetic surfaces, and the magnitude of the rotational transform as obtained by means of a pulsed electron beam have been taken into account. The time dependence of the temperature of the emitter and the elliptical shape of the cross sections of the magnetic surfaces are also considered. The measured peak ion densities and even their dependence on time agree fairly well with the calculations as long as ion inertia can be neglected. Equilibrium breaks down if the required velocity of the balancing mass flow exceeds about the ion thermal velocity. In the transition region estimates taking into account the effect of ion inertia seem to show agreement with the observations.
Author (NSA)

**N69-13866#** Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics.
**PLASMA VORTICES IN THE COAXIAL ACCELERATOR, VOLUME 1 Interim Technical Report**

Elliot Farber and Wilston H. Bostick Feb. 1968 105 p refs
(Grant AF-AFOSR-465-67)
(AD-676661; AFOSR-68-1668; SIT-P220; ITR-1-VOL-1) Avail: CFSTI CSCL 20/9

The flow of plasma in a coaxial accelerator of large aspect ratio and with center conductor negative is studied with a variety of diagnostic techniques. Measurements of radial current density, azimuthal magnetic field, radial and axial electric fields, ion density and plasma flow density are utilized to detect and study plasma vortices behind the current sheet. The most salient characteristic of the plasma vortex is the rotation of plasma without shear as in the ideal hydrodynamical vortex core. A model of the plasma vortex based on the guiding center equations is constructed. Agreement between this model and experimental results is favorable. Author (TAB)

N69-13879# Nagoya Univ. (Japan). Inst. of Plasma Physics.
**A NEGATIVE V DOUBLE PRIME WAVY TOROIDAL FIELD WITH HELICAL MULTIPOLE**
Kenro Miyamoto Oct. 1968 13 p refs
(IPPJ-74) Avail: CFSTI

A hybrid of wavy toroidal field and helical multipole is considered to form an average minimum B toroidal field without internal conductors. The magnetic surface, V'', and the rotational transform angle of the hydrid field are analysed by the average method. Several features of this configuration are derived. Author

N69-13893# Royal Inst. of Tech., Stockholm (Sweden). Microwave Dept.
**GENERATION AND AMPLIFICATION OF MICROWAVES BY INTERACTION OF ELECTRON BEAMS AND PLASMA**
**Final Scientific Report, 1 Jun. 1965–30 Jun. 1968**
B. Agdur Jul. 1968 19 p refs
(Contract AF 61(052)-895)
(AD-676704; RADC-TR-68-413) Avail: CFSTI CSCL 9/1

A summary is given of the work carried out over the three years covered by the contract. The subjects which have been treated are: Diagnostics and fundamental properties of gaseous discharges; Wave instabilities in gaseous discharges; Nonlinear wave interaction in gaseous discharges; Passive wave propagation and coupling problems in gaseous discharges; Diagnostics and fundamental properties of semiconductor plasmas; Wave instabilities in semiconductors; and Passive wave propagation in semiconductors. Author (TAB)

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Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N69-12815 Brown Univ., Providence, R. I.
**A STUDY OF DISLOCATIONS IN GALLIUM SINGLE CRYSTALS**
Samuel Hanford McFarlane, III (Ph.D. Thesis) 1967 142 p
Avail: Univ. Microfilms: HC $6.80/Microfilm $3.00 Order No. 68-1481

The dislocations in nearly perfect gallium crystals have been examined at room temperature by an X-ray diffraction topographic method. Several possible mechanisms for the origin of dislocations during crystal growth are examined and found to be largely inoperative due to the particular method of growth used and to the fact that the melting temperature of gallium (29.9°C) is only a few degrees above room temperature. Dislocation loops were observed to develop into tangled networks in crystals which exhibited a periodic fluctuation in impurity concentration. The loops began appearing a few days after the crystal was grown and increased in size and density over a period of many days. The loops grew at a uniform rate of $10^{-8}$ cm/sec. The multiplication of dislocations in several crystals was observed while the crystals were under an applied tensile stress. The work provided the first unambiguous verification of the effect of the "X-ray fan" on the diffuseness of the X-ray image on anomalous transmission topographs. Dissert. Abstr.

N69-12818 Virginia Univ., Charlottesville.
**THE EFFECT OF FREE SURFACES ON THE PLASTIC PROPERTIES OF FCC METAL CRYSTALS**
Johan Frans Prins (Ph.D. Thesis) 1967 131 p
Avail: Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 67-17660

The stress fields of screw and edge dislocations in the immediate neighborhood of a free surface have been calculated. The dislocations were assumed to lie parallel to the surface and the changes of the stress distribution as dependent on distance from the surface and on the inclination of the glide planes against the surface were determined. The results obtained were used to find the glide interaction stress between two dislocations in the vicinity of a free surface on neighboring parallel glide planes. The image force which acts on a glissile dislocation when passing an anchored parallel dislocation, has been taken into consideration. The results of the calculations have been discussed with regard to glide phenomena in f.c.c. metals. Dissert. Abstr.

N69-12622 Minnesota Univ., Minneapolis.
**STUDY OF ELECTRONIC PROCESSES AND FLUCTUATION PHENOMENA IN OPTICALLY QUENCHED CdS AND CdSe CRYSTALS**
Peter Robert Harzfeld (Ph.D. Thesis) 1967 128 p
Avail: Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 68-1617

The generation-recombination mechanism, the drift-diffusion process, and current fluctuations in optically quenched CdS and CdSe crystals were studied by means of noise measurements. The experimental work included crystal growing, deposition of ohmic contacts and determination of electron and hole trap densities. The CdS and CdSe crystals were irradiated by visible light (band to band transition) to induce photoconductivity and by an infrared beam to quench it. We then measured the photocurrent noise. We have found that quenching affects the noise spectrum. The problem has been investigated theoretically by solving the coupled partial, differential equations for the transport of the fluctuations using Green's functions. The Green's functions, and consequently the theoretical noise spectrum was split into two parts. Infrared quenching is the most effective at the surface; inducing strong surface recombination. Dissert. Abstr.

N69-12723# Case Western Reserve Univ., Cleveland, Ohio. Solid State Group.
**WAVES IN FERROMAGNETIC METALS Final Report**
Eric D. Thompson May 1968 43 p refs
(Grant AF-AFOSR-857-66)
(AD-676015; AFOSR-68-1324) Avail: CFSTI CSCL 20/12

A research summary of the Solid State Magnetics Group activities is given. Included is a listing of the personnel associated with this grant and a listing of the technical talks, theses, and publications resulting from this grant. Major achievements include the understanding of the spin wave dispersion in the ferromagnetic

fcc metals, the thermodynamic implications of the spin wave dispersion and the first direct observation of spin waves in Pd-Fe. Author (TAB)

N69-12779 Illinois Univ., Urbana.
**PART 1. PROXIMITY EFFECT: NUMERICAL EVALUATION OF $T_c$. PART 2. DERIVATION OF BOLTZMANN TYPE TRANSPORT EQUATION FOR AN IMPURE ANISOTROPIC SUPERCONDUCTOR**
Robert Hsiang-Tao Yeh (Ph.D. Thesis) 1967 149 p
Avail: Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 68-1888

De Gennes' equation for the gap parameter in superposed films of normal and superconducting materials have been solved via a numerical technique based upon a variation approach used by Silvert and Cooper. The solution indicates that the approximate analytical procedure used by Werthamer is accurate for thick-dirty films. However, for thinner-cleaner films, his approximate calculation of $T_c$ is shown to lead to errors as big as 25%. Our calculation leads to an improved agreement between theory and experiment. Khalatnikov's kinetic equation for an anisotropic superconductor is derived via a Green's function technique, for a case in which the electrons in a weak coupling anisotropic superconductor are scattered by non-magnetic impurities. Dissert. Abstr.

N69-12893 Missouri Univ., Columbia.
**ANHARMONIC CONTRIBUTION TO THE DEBYE–WALLER FACTORS**
Gordon Aretes Wolfe (Ph.D. Thesis) 1967 149 p
Avail: Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 68-333

First order anharmonic contributions other than those due to thermal expansion, which are proportional to the second and fourth powers of the scattering vector are calculated. The quantities to be calculated are examined in their direct-space representation; those of long range in direct space are evaluated in reciprocal space. The unbounded singularity occurring in the reciprocal-space integrals is carefully treated. The resulting direct-space sums converge well and are simpler quantities than those resulting from the phonon technique in that there are no multiple integrals in reciprocal space, and the frequencies and polarization vectors do not appear. The calculations are carried out for copper using two sets of second order and three sets of third and fourth order coupling parameters. The values obtained are compared to experimental values and the other calculations. Dissert. Abstr.

N69-12898 Illinois Univ., Urbana.
**THE ELASTIC STRESS FIELD PRODUCED BY A POINT FORCE IN A CUBIC CRYSTAL**
Kyoon-Haeng Choh Lie (Ph.D. Thesis) 1967 103 p
Avail: Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 68-1798

Fredholm in 1900 gave a solution in principle for the displacements generated by a point force at the origin in an infinite elastic solid. Eshelby in 1955 gave an approximate solution of the dilatation for the triple force at the origin with no moment. The present calculation uses Fredholm's work to provide a Fourier expension of displacement which converges for all stable cubic crystals. The convergence of the series giving the displacement due to a point force is very slow for lithium. Detailed calculations of stress fields have been made for aluminum and copper. The elastic interaction energies of two triple double force interstitials and of two single double force interstitials with no moment are calculated. The calculated stresses are accurate to about 15 and 8 percent of their value for copper and aluminum respectively. Dissert. Abstr.

N69-12900# Istituto Superiore di Sanita., Rome (Italy). Laboratorio di Fisica.
**THERMOREFLECTANCE SPECTRUM OF SILICON**
A. Balzarotti (Aquila Univ., Italy) and M. Grandolfo 5 Sep. 1968 14 p refs Submitted for publication
(ISS-68/25) Avail: CFSTI

The thermoreflectance spectrum of Si, measured in the 3–6 eV region at normal and oblique incidence with polarized light, is presented. Structures in $\Delta\epsilon_2$, the temperature-induced change of the imaginary part of the dielectric constant, occur at the energies of the interband transitions near critical points. The temperature coefficients of these singularities are given. Author

N69-12909# California Univ., Berkeley. Lawrence Radiation Lab.
**ELECTRICAL LOSS MEASUREMENTS IN NbTi MAGNET**
Ferd Voelker 25 Jul. 1968 13 p refs
(Contract W-7405-ENG-48)
(UCRL-18374) Avail: CFSTI

A superconducting solenoid wound with NbTi wire copper clad was used in developing an electrical method for measuring ac losses. The maximum field on axis is ≈70 kG at 120 A. The method measures the accumulated electrical energy entering the magnet over a period of several cycles; the measuring circuit includes a multiplying circuit and an integrator for measuring the energy balance in the magnet. The variables studied include maximum current, hysteresis, eddy current losses, and flux jumps. NSA

N69-12915# Ballistic Research Labs., Aberdeen Proving Ground, Md.
**CRYSTALLOGRAPHY OF UNIAXIAL STRAIN DEFORMATION**
Gerald L. Moss and William J. Gillich Aug. 1968 17 p refs
(AD-676111; BRL-1414) Avail: CFSTI CSCL 20/2

An analysis is developed for the rotation of an arbitrary crystal plane under conditions of unidirectional strain. A discussion is given that specifies realistic types of loading under which the analysis is applicable. Certain physical variables that are effected by reorientation of the crystal planes and that would influence the deformation process are considered. Types of deformation mechanisms that are effected are also indicated. Author (TAB)

N69-12928# Illinois Univ., Urbana. Dept. of Mining, Metallurgy and Petroleum Engineering.
**THE FREQUENCY DEPENDENCE OF DISLOCATION DAMPING IN B.C.C. NIOBIUM**
Bidyut Kumar Ganguly Aug. 1968 36 p refs
(Contract AT(11-1)-1198)
(COO-1198-564) Avail: CFSTI

The frequency dependence of the amplitude-independent dislocation damping in high purity niobium single crystals was measured in the megacycle frequency range. Measurements of the dislocation contribution to the elastic modulus were also carried out in this frequency range. The results are discussed in terms of a theoretical calculation which treats the dislocation as a pinned vibrating string which experiences a viscous drag proportional to its velocity. The data are consistent with a curve of the form $K\omega\tau/1 + \omega^2\tau^2$ as calculated from the vibrating string model. On the high frequency side of the maximum, the dislocation damping exhibited a $\omega^{-1}$ dependence as expected from the theory. The effect of various interstitial solute contents on the damping was shown to be consistent with the calculated dependence of the damping on pinning point concentrations. The viscous damping constant was calculated from the damping and from etch pit determinations of the dislocation density to be about $9 \times 10^{-5}$ dyne-sec per $cm^2$. Author (NSA)

N69-12938 Cornell Univ., Ithaca, N. Y.
**THE F CENTER IN CESIUM FLUORIDE**
Theodore Alan Fulton (Ph.D. Thesis) 1967 305 p
Avail: Univ. Microfilms: HC $13.75/Microfilm $3.95 Order No. 68-676

Optical absorption F band lineshape and its temperature, magnetic field and stress dependence, and the photoconductivity, luminescence, and ground-state repopulation behavior of cesium fluoride F centers were studied. The F band possesses a well-resolved triplet structure. The magnetic circular dichroism measurements show that the P states are split by a large spin-orbit coupling. An unusual feature in the F-band lineshape is the presence of structure due to optical transitions in which zero, one or more optical phonons of cubic symmetry are created. The photoconductivity and certain optical bleaching experiments show that the lattice relaxation processes which follow the absorption of a photon depend upon whether the electron is excited to the $P_{1/2}$ or $P_{3/2}$ state. Luminescence and ground-state repopulation measurements have revealed an unusual discrepancy between the luminescence lifetime, 50 nsec., and the time required for the electron to return to its ground state after excitation, 1 μsec. Dissert. Abstr.

N69-12975 Illinois Univ., Urbana.
**EQUILIBRIUM VACANCY CONCENTRATION MEASUREMENTS AND THERMAL PROPERTIES OF SOLID KRYPTON**
David Lawrence Losee (Ph.D. Thesis) 1967 108 p
Avail: Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 68-1801

Simultaneous length and X-ray lattice parameter expansion measurements have been made on three 6 mm diameter cylindrical specimens of 99.995% purity krypton. The specimens were prepared and held unconstrained in a rigid-tail cryostat in which specimen temperatures could be precisely controlled. The data show a divergence between the bulk and lattice expansions at the higher temperatures which indicates an appreciable concentration of thermally generated defects at temperatures above 75°K. The equilibrium atomic vacancy concentration inferred from these measurements appears to be represented by $n = \exp[(2.0 \pm 0.5) - (895 \pm 100°K)/T]$. The monovacancy formation enthalpy and entropy is discussed and compared with other existing theoretical and experimental information on argon and krypton. It appears that the enthalpy of formation for the monovacancy in krypton may not be entirely accounted for by two-body central-force interactions. Dissert. Abstr.

N69-13000# Lancaster Univ. (England). Dept. of Physics.
**LOCAL FIELDS AROUND SCREENED IMPURITY ATOMS**
B. A. Keating and P. M. Lee *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 553–557 refs (See N69-12994 03-17)
Avail: CFSTI

A model of a finite metal was used to determine the potentials and fields around screened impurity atoms in metals. The self consistency of a vacancy potential was checked numerically with the model and fields around screened zinc atoms in copper were calculated. The application of the results to a zinc solute atom in copper metal are discussed. More generally, it is shown that the eigenvalues for perturbed states in the model are less affected by a screened ion core due to orthogonality requirements on the wave functions with regard to core states on the impurity. Author

N69-13001# Giessen Univ. (West Germany). Inst. for Theoretical Physics.
**INFLUENCE OF POINT DEFECTS ON ELASTIC CONSTANTS**
M. Pistorius and W. Ludwig *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 559–573 refs (See N69-12994 03-17)
Avail: CFSTI

The elastic constants of bcc and fcc crystals with vacancies and interstitials are calculated. The interatomic interaction is assumed to consist of central forces between nearest and next nearest neighbors in the ideal lattice and a similar assumption for the defect region. Difficulties arise mainly from the poor knowledge of the force constants between the defect atom and its neighbors, unless the force constants are not used as free parameters to be determined by experiment. Special emphasis is put on the calculation of internal displacements around the defect as produced by external stresses or a homogeneous strain field at large distances from the defect. The model used is not quite adequate for metals, but the main features can be seen. Author

N69-13002# Academie R. P. R., Bucharest. Inst. for Atomic Physics.
**LATTICE DISTORTION AROUND A POINT DEFECT IN A F.C.C. CRYSTAL**
D. Grecu and M. Croitoru *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 574–586 refs (See N69-12994 03-17)
Avail: CFSTI

The problem of lattice distortion around a point defect is discussed for a f.c.c. crystal in the hypothesis of short range interactions between atoms and in the harmonic approximation for the potential energy. The symmetry properties of the crystal with defect are used to determine new force tensors between the atoms in a small region around the defect. The relaxation process from the perfect lattice configuration to the deformed one takes place through successive equilibrium configurations, with the same force tensors. The forces acting on the atoms in the different intermediate stages are determined from the invariance requirement of the potential energy with respect to a rigid body rotation of the crystal. A radial deformation is obtained as consequence of the symmetry point group used to determine the force tensors. Author

N69-13003# Brookhaven National Lab., Upton, N. Y.
**ATOMIC DISPLACEMENTS AROUND DISLOCATION LOOPS**
D. T. Keating and A. N. Goland *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 587–597 refs Supported by AEC (See N69-12994 03-17)
Avail: CFSTI

The displacement field around a penny-shaped inclusion or void in an isotropic elastic medium was computed by the methods outlined by Sneddon. The boundary conditions for such a loop are that in the plane of the loop, $z = 0$, the displacement is $\pm|b|/2$ for r less than the loop radius, c, and zero outside the loop; and that the shear stress in the r direction across this plane is zero everywhere. The actual atomic displacements are represented by this displacement field beyond a few atomic diameters of the loop. The solutions for the r and z components of the displacement field are given in series form, and contour plots for these components are generated by a CDC-6600 computer for Poisson's ratio, $\sigma = 0.30$. At large distances from the loop the series expressions for the displacement field converge to that of a single doublet force without moment oriented in the z direction plus a point singularity at the center of the loop. The strengths of these two singularities are expressed in terms of the dimensions of the loop, |b| and c, and $\sigma$. From these strengths the lattice dilatations including image effects were calculated for a finite medium with a uniform distribution of loops. Author

N69-13004# North Carolina State Coll., Raleigh.
**INTERACTIONS OF VACANCIES AND INTERSTITIALS WITH FREE SURFACES AND GRAIN BOUNDARIES**
R. J. Beeler, Jr. *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 598-618 refs (See N69-12994 03-17) *In* Kernforschungsanlage Intern. Conf. on Avail: CFSTI

The free surface calculations for $\alpha$-iron were made by the variational method; the grain boundary calculations for nickel were made by the quasi-dynamic method. These studies were based on Johnson's potentials for $\alpha$-iron and nickel. Although single vacancies, divacancies, and trivacancies retained their identity in and near free surfaces, their migration energies were markedly changed from 0.11 to 1.4 times the respective migration energies in the bulk phase. A vanishingly small vacancy concentration in the first interior plane beneath (110) and (112) free surfaces was indicated. Slightly bound vacancy pair configurations, involved in divacancy and trivacancy migration, in the bulk phase, transformed spontaneously to the most stable divacancy configuration near a free surface. In the bulk phase an activation energy of 0.73 $E^{M}_{1R}$ is required for this transformation. Both (T10) and (110) split interstitials were more stable against annihilation at (110) free surface than they were against recombination with a single vacancy in the bulk phase. This enhanced stability arises from the ability of the free surface to disperse the interstitial strain field. Author

N69-13007# Technische Hochschule Stuttgart (West Germany). Inst. fuer Theoretische und Angewandte Physik.
**COMPUTER SIMULATION OF POINT DEFECT ANNEALING**
H. Mehrer *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 643-658 refs (See N69-12994 03-17)
Avail: CFSTI

Random walks and annealing processes of point defects in cubic lattices have been simulated by means of a Monte Carlo method. The simulated annealing of monovacancies at an unfillable sink is compared with results of the diffusion theory. Afterwards the method is applied to the precipitation of mono- and divacancies. The recombination kinetics of either non-interacting or interacting interstitials and vacancies is investigated. The application of the method to more complicated annealing processes and reactions of point defects is discussed. Author

N69-13008# Czechoslovak Academy of Sciences, Prague. Inst. of Solid State Physics.
**THE MEAN JUMP NUMBER OF A VACANCY IN ANNEALING EXPERIMENTS**
P. Streda *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 659-668 refs (See N69-12994 03-17)
Avail: CFSTI

The mean jump number $\bar{m}$ which a vacancy makes during its life in a nearly perfect lattice, before it is absorbed in a sink is calculated. The sinks are assumed unfillable and there is no interaction between the vacancies. The dependence of $\bar{m}$ on the shape and size of the sink in the f.c.c. lattice is discussed. Author

N69-13026# Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik.
**A RELAXATION PROCESS DUE TO LONG-RANGE DIFFUSION OF HYDROGEN AND DEUTERIUM IN NIOBIUM**
G. Schaumann, J. Voekl, and G. Alefeld *In its* Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 881-885 refs (See N69-12994 03-17)
Avail: CFSTI

A new method for the determination of diffusion coefficients is presented for the example of hydrogen and deuterium in niobium. In contrast to observations on isotopes of heavy elements, the activation energy for deuterium (135±5 meV) differs from that for hydrogen (110±5 meV) by about 20%, whereas $D_0 = (5.5 \pm 0.6) \cdot 10^{-4}$ cm$^2$/sec is the same within experimental error. Author

N69-13027# European Atomic Energy Community, Ispra (Italy). Reactor Physics Dept.
**THEORETICAL STUDIES ON THE DYNAMICS OF INTERSTITIAL HYDROGEN IN bcc LATTICES**
G. Blaesser and J. Peretti *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 886-900 refs (See N69-12994 03-17)
Avail: CFSTI

Our studies concern in particular localized vibrations and diffusive motion of the interstitials. For dealing with the localized vibrations a new method was developed which avoids the solution of a secular determinant and gives simple explicit formulae for the frequencies of an interstitial in a bcc-lattice. To account for the lifetimes of the localized peaks as well as for the quasielastic neutron scattering further studies have been concerned with the diffusive motion of the hydrogen and two models are being investigated: a classical multiple-site jump diffusion model and a quantum mechanical proton-band model. Author

N69-13028# Amsterdam Univ. (Netherlands). Natuurkundig Laboratorium.
**ISOTOPE EFFECTS IN THE JUMP FREQUENCY OF H AND D IN THE $\beta$-PdH SYSTEM**
R. R. Arons *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals, Vol. 2 Sep. 1968 p 901-910 refs (See N69-12994 03-17)
Avail: CFSTI

The jump frequency of H and D in the $\beta$-phase of the PdH system was measured from 55-125°K by elastic after-effect and internal friction. The activation energy obtained by the former method was found to be 0.16 eV. This value is about 0.07 eV smaller than found by internal friction. The results are explained by tunneling. Author

N69-13040# Brookhaven National Lab., Upton, N. Y.
**INFLUENCE OF INTERSTITIAL CARBON IN IRON ON THE SCATTERING OF X-RAYS**
A. N. Goland and D. T. Keating [1968] 15 p refs Presented at the Intern. Conf. on Vacancies and Interstitials in Metals, Juelich, Ger.
(BNL-12711; CONF-680910-1) Avail: CFSTI

With the aid of recent calculations of the doublet-force displacement field about a carbon interstitial in $\alpha$-iron, the x-ray diffuse scattering was calculated in the vicinity of the reciprocal lattice points in iron-carbon martensite and in ferrite. Contours of the diffuse scattering in electron units per iron atom divided by p(1-p), where p is the fraction of carbon atoms, are given for both martensite and ferrite. In martensite, the contours are of a complicated shape, often quite different from those for defects with spherical symmetrical symmetry. Reflections of the type (OOL) and (HKO) always show nodal planes perpendicular to the vector from (OOO) to (HKL). The diffuse scattering at (OOO), the small angle scattering shows the cylindrical doublet symmetry. The results for martensite and ferrite reveal that the origin scattering exhibits the orientation and symmetry of a defect in a more direct manner than the diffuse scattering about any other point in reciprocal space. Author (NSA)

**N69-13087#** Czechoslovak Academy of Sciences, Prague. Inst. of Solid State Physics.

**THE DYNAMIC EQUILIBRIUM OF POINT DEFECTS IN METALS**

K. Misek and P. Vasek. *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 19–29 refs (See N69-13085 03-17)

Avail: CFSTI

The system of simultaneous differential equations, which describe the reactions between vacancies and impurities in f.c.c. metals, is used to the determination of equilibrium concentrations of divacancies and impurity-vacancy complexes. The relations between the local atomic frequencies and the entropy of association are also determined. Author

**N69-13088#** Ludwig-Maximilians-Universitat, Munich (West Germany).

**THERMAL AND RADIATION ENHANCED SELF-DIFFUSION IN GOLD SINGLE CRYSTALS AT LOW TEMPERATURES**

V. Ermert, W. Rupp, and R. Sizmann. *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 30–42 refs (See N69-13085 03-17)

Avail: CFSTI

With an improved electrochemical sectioning technique we succeeded in removing about 20Å thick layers in a controlled manner from gold single crystals. With this technique diffusion profiles of radioactive gold of only about 1000 Å depth can be accurately determined. Radiation enhanced self-diffusion by irradiation with 3.0 MeV $\alpha$-particles at a flux density of $5 \cdot 10^{10}/cm^2$ sec. up to a total dose of $5 \cdot 10^{15}$ $\alpha/cm^2$ yields a practically temperature independent enhanced diffusion coefficient of $D = 1.3 \cdot 10^{-16} cm^2/sec$ in the region 60 to 150°C. At lower temperatures (between 10 and −18°C) the estimated enhanced diffusion coefficient is $D = 6 \cdot 10^{-17} cm^2/sec$. Below −60°C no diffusion is observable. In the higher temperature region excess vacancies and interstitials contribute to the enhanced diffusion; in the lower temperature range it is likely that only interstitials promote the diffusion. Author

**N69-13090#** Chalmers Univ. of Technology, Goteborg (Sweden). Dept. of Physics.

**ELECTROTRANSPORT AND THERMOTRANSPORT IN LITHIUM**

P. Thernquist and A. Lodding. *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 55–68 refs (See N69-13085 03-17)

Avail: CFSTI

The mobilities of defects and impurities in lithium have been studied by observing the motion of inert lattice markers, of stable isotopes or of radioactive tracers, induced by potential gradients (electrotransport) or by temperature gradients (thermotransport). The electrotransport experiments on pure Li indicate an effective defect resistivity of about 0.8 micro-ohms/% def., mass transport directed towards the anode. The thermotransport experiments give a heat of transport of about +8 kcal/mole with mass transport towards the cold region, while the isotope effect of thermotransport is anomalously directed towards the hot region. From the temperature characteristics of both electro- and thermotransport one deduces an activation energy close to that of self-diffusion (12.8 kcal/mole). The thermotransport of $^{195}Au$ in Li enriches the tracer in the cold region. The transport mechanism in lithium appears to be governed by composite defects rather than "classical" vacancies. Author

**N69-13091#** Muenster Univ. (West Germany).

**DETERMINATION OF THE CHARGE AND THE RESIDUAL RESISTIVITY OF ACTIVATED IMPURITY-VACANCY COMPLEXES IN METALS BY ELECTROTRANSPORT**

Th. Hehenkamp, Ch. Herzig, and Th. Heumann. *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 69–81 refs (See N69-13085 03-17)

Avail: CFSTI

In order to check different theories for electrotransport, which have not been confirmed quantitatively, electrotransport, diffusion and residual resistivity of antimony in gold have been precisely measured. The results seem to best fit a model given by Huntington. A quantitative evaluation is possible for the first time. The results yield a value of 3.3e for the screened charge of the activated antimony-vacancy complex. It is assumed that the residual resistivity of the antimony impurity which yielded 6.66 $\mu\Omega cm/At\%$ is almost identical with that of the activated complexes. It has to be concluded that the charge of the impurity on normal lattice positions does not differ significantly from the charge of the activated complex. Further, the results show that the correlation coefficient for jumps between vacancies, the Sb-impurities and gold atoms does not vary in the limits of the experimental errors. Author

**N69-13099#** Ecole National Superieure de la Metallurgie et de l'Industrie des Mines, Nancy (France). Laboratoire de Physique du Solide.

**VACANCY-IMPURITY INTERACTION DURING AND AFTER QUENCHING OF DILUTE SOLID SOLUTIONS OF COPPER IN NICKEL**

B. Deviot, H. Octor, and S. Scherrer. *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 176–184 refs (See N69-13085 03-17)

Avail: CFSTI

A 15,000° C/sec initial quenching rate does not retain vacancies in 0.08 mm diameter high purity nickel wires. Small copper concentration has been introduced to do so. Plots of isochronal annealing show a copper concentration dependence; two stages are noticeable: stage one (A) around 500°K, its amplitude increases with the copper content and follows a first order kinetics with a 1.53 eV activation energy. This stage is interpreted as resulting from vacancy-impurity complexes. Stage two (B), between 800 and 1000°K, would be due to the annealing of clusters formed during the quench or stage A. A 0.25 eV vacancy-impurity binding energy is then deduced. Author

**N69-13105#** Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik.

**THE INFLUENCE OF SPONTANEOUS RECOMBINATIONS AND SUB-THRESHOLD EVENTS ON THE DEFECT PRODUCTION AT LOW TEMPERATURE ELECTRON IRRADIATIONS**

G. Duesing, H. Hemmerich, W. Sassin, and W. Schilling. *In its* Intern Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 248–274 refs (See N69-13085 03-17)

Avail: CFSTI

The resistivity increase per unit irradiation dose in pure aluminum, copper and platinum containing Frenkel defects in different concentrations or quenched-in vacancies (Pt only) is determined. The highest electron doses achieved at 4.2°K are $\approx 10^{20}$ electrons/$cm^2$. By means of radiation doping and subthreshold irradiation (Pt) it is shown that the build-up of defects in these metals is governed by spontaneous recombination processes during defect production as well as by radiation induced recombination of close pairs resulting from nearby sub-threshold energy transfer to the lattice during irradiation. Approximate values for the cross sections of these processes are determined. Quenching enhances the number of spontaneous recombinations and gives rise to an apparent increase of the damage rate at low defect densities probably due to deviations from Matthiessen's rule. Author

**N69-13112#** United Kingdom Atomic Energy Authority, Harwell (England). Metallurgy Div.

**DILATOMETRIC STUDIES OF RADIATION DAMAGE IN METALS**

S. N. Buckley *In* Kernforschungsanlage Intern. Conf. on Vacancies and Interstitials in Metals Sep. 1968 p 355-363 refs (See N69-13085 03-17)

Avail: CFSTI

Although dilatometry offers the distinct advantage of discriminating between vacancies and interstitials, it has not hitherto been regarded as an attractive method for studying defect migration because specimens thin enough to be transparent to charged particles of a few MeV energy are too delicate to actuate conventional mechanical or electrical sensors. The present paper describes how this inherent insensitivity was mitigated by measuring the inhomogeneity of defect concentration instead of the average concentration. These concentration gradients were deduced by measuring the flexures induced in thin crystal foils during irradiation by a 2 1/2 MeV proton beam from a Van de Graaff accelerator. Foil thicknesses were adjusted so that the beam energy was attenuated by a 1/2 MeV in passing through; the $E^{-1}$ dependence of Rutherford scattering them resulted in an approximately linear 20% gradient in Frenkel pair generation rate across the foil thickness, and strains associated with the ensuing accumulation of defects flexed the foil. Author

**N69-13125#** Cornell Univ., Ithaca, N. Y. Materials Science Center.

**FLUX CREEP IN HARD SUPERCONDUCTORS**

Malcolm Roy Beasley (Ph.D. Thesis) Jun. 1968 139 p refs (Contract AT(30-1)-3029)

(NYO-3029-29; Rept.-921) Avail: CFSTI

Flux creep in the critical state of some typical hard type-2 superconductors was investigated in order to improve the basic understanding of the flux creep process and to assess the usefulness of flux creep measurements as a probe of the basic fluxoid pinning mechanisms. The measurements were made using a very sensitive magnetometer incorporating a superconducting quantum interference device as the flux sensing component. The details of this system are described, and its general usefulness and limitations are discussed. The observed flux changes showed the logarithmic time dependence characteristic of flux creep, and the creep rate was studied as a function of magnetic history, cold working, specimen size, and to some extent temperature. Except at low fields, the detailed results were found to be in agreement with the behavior expected on the basis of the Anderson-Kim flux creep theory and to provide quantitative results for the material sensitive parameters of the theory (i.e., the pinning energy and the activation volume or flux bundle size). Author (NSA)

**N69-13144#** United Kingdom Atomic Energy Authority, Harwell (England). Information Branch.

**SIMULATION OF THE RANDOM MOTION AND QUASI-CHEMICAL REACTIONS OF POINT DEFECTS IN CRYSTALS BY MEANS OF ELECTRONIC COMPUTERS**

A. Scholz Dec. 1967 25 p refs Transl. into ENGLISH from Phys. Status Solidi, v. 14, 1966 p 169-179

(AERE-TRANS-1103) Avail: CFSTI

Interconversions of point defects can be described by quasi-chemical reactions, which are mathematically expressed by reaction kinetic equations, which in the steady state give the laws of mass action. An electronic computer was used to simulate defect reactions in fcc crystal lattices, ALGOL being used for programming. Simulation of the reaction processes was equivalent to treating the equations by Monte Carlo methods. The simulation process is explained in detail, with samples. NSA

**N69-13172#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**COMPOUND WITH STRUCTURE TYPE W SUB 6 Fe SUB 7 IN AN Mo-Ni-Si SYSTEM [SPOLUKA Z STRUKTUROYU TYPU W SUB 6 Fe SUB 7 V SYSTEMI Mo-Ni-Si]**

R. V. Skolozdra et al *In its* Ukrain. J. of Phys. 27 Sep. 1967 p 7-9 refs (See N69-13170 05-34)

Avail: CFSTI

The crystal structure of the phase $Mo_6(Ni_{0.75}Si_{0.25})_7$ was determined by means of X-ray diffraction. The structure belongs to the $W_6Fe_7$ type with high coordination numbers. Author

**N69-13183#** Library of Congress, Washington, D. C. Aerospace Technology Div.

**SCIENCE'S SECOND MOST IMPORTANT ASSIGNMENT: HIGH-TEMPERATURE SUPERCONDUCTORS**

Zygmunt Litvnski *In its* Foreign Sci. Bull., vol. 4, no. 12 Dec. 1968 p 25-34 refs (See N69-13181 03-34)

Avail: CFSTI

Soviet studies of superconductivity are briefly reviewed and possibilities of non-phonon mechanisms, which would account for high-temperature superconductors, are indicated as based on the most recent works by Geylikman and Ginzburg. Author

**N69-13187** Illinois Univ., Urbana.

**THERMAL CONDUCTIVITY OF SUPERCONDUCTING TIN FILMS IN A MAGNETIC FIELD**

John Ernest Smith, Sr. (Ph.D. Thesis) 1967 105 p

Avail: Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 68-1859

The magnetic field dependence of the thermal conductivity of superconducting tin films in a parallel field ranging from zero to above the critical fields, and at temperatures from 0.3 to 1°K, have been measured. They had electron mean free paths $l$ which were from 18% to 85% of the bulk coherence length $\xi_0$. The Landau-Ginzburg parameter $\kappa$ was sufficiently enhanced by the effect of the short mean free paths that in thicker films it was able to observe the surface sheath region of de Gennes and Saint James. An expression for the field dependence of the thermal conductivity in this region, based upon theoretical calculations of Caroli and Cyrot and of Maki has been derived; this expression, which is strictly valid only in the limit $l/\xi_0 \to 0$, is in good agreement with our experimental results. Dissert. Abstr.

**N69-13258#** Cornell Univ., Ithaca, N. Y. Materials Science Center.

**THE M' AND R' CENTERS IN LiF: A COMPARATIVE STUDY OF ORBITAL DEGENERACY AND THE DYNAMIC JAHN-TELLER EFFECT IN OPTICAL SPECTRA**

Harold Ralph Fetterman (Ph.D. Thesis) Jun. 1968 147 p refs (Contract AT(30-1)-3464)

(NYO-3464-12) Avail: CFSTI

A comparative study of M' and R' centers in LiF, identified with the aid of uniaxial stress, was performed using both emission and absorption spectra. The effects of applied fields were investigated to determine the consequence of orbital degeneracy and the Jahn-Teller distortion. Analysis of the different spectra reveals several features which can be consistently interpreted in terms of a dynamic Jahn-Teller effect. Author (NSA)

**N69-13268#** Los Alamos Scientific Lab., N. Mex.

**SUPERCONDUCTIVITY AND THE NATURE OF THE BOND IN CARBIDES AND NITRIDES OF TRANSITION METALS AND THEIR SOLID SOLUTIONS WITH NaCl-TYPE STRUCTURE**

O. I. Shulishova [1968] 27 p refs Transl. into ENGLISH from Khim. Svyaz Poluprov. Termodin., Inst. Fiz. Tverd. Tela Poluprov. Akad. Nauk Beloruss. SSR 1966 p 299–316
(LA-TR-68-31) Avail: CFSTI

It is shown that a change in superconducting transition temperature $T_c$ is a sensitive indicator of the curve of density of states. A study was made of the $T_c$ as a function of the valence electron concentration and homogeneity of the compounds and their solid solutions. Compounds studied included: TiC, NbC, ZrC, HfC, TaC, NbN, MoC, ZrN, WC. The results generally show a maximum of $T_c$ at a valence electron concentration of 4.85 electrons/atom and a minimum at 4.2 electrons/atom. For solid solutions of isoelectronic compounds, $T_c$ changes linearly with composition. The $T_c$-valence electron correlation is compared with the correlations for other properties: electric resistance, Hall effect, and magnetic susceptibility. The curve of the density of the states is compared with curves calculated from different bond models. The explanation of the homogeneity region is considered. NSA

**N69-13341#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**TRANSIENT PROCESSES IN SUPERCONDUCTING MAGNETIC SYSTEMS [PEREKHODNYYE PROTSESSY V SVERKHPROVODYASHCHIKH MAGNITNYKH SISTEMAKH]**
V. V. Sychev et al *In its* Inter. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 288–301 refs
(See N69-13314 03-03)
(SM-74/229) Avail: CFSTI

The possibility of using large superconducting magnets with rather high field intensities determines to a great extent the promise of effective usage of MHD installations in power engineering. In the creation of superconducting magnetic systems with tremendous working volumes, complex physical, technical, and engineering problems arise. The difficulties are not limited to the necessity of producing superconducting materials with high critical parameters. A number of extremely complex problems related to various areas of science and technology must be solved. In particular, one problem of prime importance is the investigation of the range of problems connected with the fundamental properties of the windings in a superconducting magnetic system as a physical object.
Author

**N69-13420#** Kernforschungsanlage, Juelich (West Germany).
**INTERACTIONS BETWEEN CRYSTAL LATTICE DEFECTS [WECHSELWIRKUNGEN ZWISCHEN DEFEKTEN IN KRISTALLEN]**
Rolf Siems Aug. 1968 185 p refs In GERMAN
(JUL-545-FN) Avail: CFSTI

The elastic fields of defects and their elastic interactions are treated. A closed expression, first formulated by Fredholm, is derived for Green's tensor function in an infinite anisotropic medium. The explicit calculation of this expression requires the solution of a sixth-order equation which becomes simplified for directions having a certain symmetry. The significance of the elastic Green function as the first member in the asymptotic development of the lattice theory Green function is pointed out. The second member of this development is also calculated for a very simple lattice model. Generalized expressions are derived for the changes in the volume of a body due to external forces, and the changes in volume caused by inner stresses are discussed. The identification of point defects by means of force multipoles as well as the elastic field of point defects are discussed and applied to a variety of geometries. Energies of point defects in the elastic field and expressions for the interaction energy of the point defects are obtained and applied to point defects in isotropic media. Displacement solutions for the elastic equations are described within the formalism of the elasticity theory. Finally, the interactions between a small-angle grain boundary and a dislocation are investigated.
Transl. by K.W.

**N69-13447#** Virginia Univ., Charlottesville. Dept. of Physics.
**SURFACE SCATTERING AND OTHER SURFACE PHENOMENA Final Technical Report**
N. Cabrera Jul. 1968 10 p refs
(Grant AF-AFOSR-1136-66)
(AD-676702; AFOSR-68-1900) Avail: CFSTI CSCL 20/12

This Grant permitted the initiation of a theoretical solid state physics group in the University of Virginia, which now consists of about seven faculty members. The program of Surface Physics which it was supposed to develop has really just started, but in a very promising way. Substantial and important contributions have been made to the theories of: magnetic and superconducting properties of solids; resonance elastic and inelastic scattering of light atoms from solid surfaces; and thermodynamics of surfaces. Work has progressed also on two other topics, although no substantial success has been achieved yet - namely, establishment of a bridge between quantum-mechanical theories of scattering of light gases from solid surfaces and the corresponding classical-mechanical theories for heavy gases; and, motion of defects in crystal lattices.
Author (TAB)

**N69-13511#** Maryland Univ., College Park. Dept. of Physics and Astronomy.
**THEORY OF INTERACTING ELEMENTARY EXCITATIONS IN SOLIDS Final Report, 1 Sep. 1964–30 Nov. 1967**
Richard A. Ferrell and Richard E. Prange Jun. 1968 15 p refs
(Grant AF-AFOSR-735-65)
(AD-676281; AFOSR-68-1038) Avail: CFSTI CSCL 12/12

This is the final report of the work performed in theoretical Solid State Physics at the University of Maryland under Grant No. AF-AFOSR-735-65, supported by the Air Force Office of Scientific Research. Investigations in problems in superconductivity, normal metals, magnetism, and fluctuations and phase transitions are described. The personnel supported by the Grant as well as the students trained are listed. Also listed are the publications and theses produced under this Grant.
Author (TAB)

**N69-13548#** Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Electrical Engineering.
**SEMICONDUCTOR HETEROJUNCTION STRUCTURE STUDIES Interim Report**
Donald L. Feucht and Arthur G. Milnes Jun. 1968 93 p refs
(Contract F19628-68-C-0179)
(AD-676304; AFCRL-68-0340; SR-1) Avail: CFSTI CSCL 20/12

Feasibility studies have been made of semiconductor heterojunction structures and confirm that wide-gap emitter action is practical. Transistors of n-type ZnSe emitters on pGe-nGe base-collector structures have usable current gains even though the emitter doping levels are many orders of magnitude lower than the base doping levels. Effects on the current gain of parameters such as doping levels, base widths, current injection levels and temperature have been studied. Because of the low emitter doping levels, the emitter current flow is space-charge limited. The ZnSe was grown epitaxially on the Ge substrate by a close-spaced HCl transport process from doped source material. The optical properties of nZnSe-pGE junctions showed window-effect corresponding to the energy gap difference 2.6eV to 0.7eV. However, measurement of the photon quantum efficiency was not attempted with these specimens because of the high resistivity of the ZnSe. Analytical studies were made of the frequency response to be expected for heterojunction transistors, with doped or space-charge limited emitters, and for a homojunction high-frequency transistor of comparable geometry. The high base doping possible with heterojunction transistors should result in low base resistance and at least a factor of two increase in the frequency response relative to homojunction transistors.
Author (TAB)

**N69-13553#** Paris Univ. (France).
**OPTICAL STUDIES OF LATTICE VIBRATION IN II-VI SEMICONDUCTING COMPOUNDS**
M. Balkanski Apr. 1968 58 p refs
(Grant AF-EOAR-0016-68)
(AD-676649; ARL-68-0184; SR-1) Avail: CFSTI CSCL 20/12

Parallel to the experimental investigations, theoretical studies have been developed and the dispersion relations calculated for some of the II-VI semiconductors compounds. The presence of foreign atoms leads to localized or resonants modes of vibration, which have been experimentally studied in many II-VI semiconductors compounds. Author (TAB)

**N69-13564#** Kansas Univ., Lawrence. Dept. of Geology.
**RADIATION DAMAGE AND CHEMICAL REACTIONS INDUCED IN CRYSTALLINE SOLIDS BY HIGH-ENERGY PROTON BOMBARDMENT Final Report, 1 Feb. 1967–1 Apr. 1968**
Edward J. Zeller and Gisela Dreschhoff Sep. 1968 25 p refs
(Contract F19628-67-C-0182)
(AD-676655; AFCRL-68-0350) Avail: CFSTI CSCL 7/5

The objectives of the research summarized in the report were twofold. First, an effort was made to determine whether heavy particle irradiation could produce significant changes in the infrared absorption characteristics of various substances. Second, after having observed that substantial changes were produced, an attempt was made to determine the nature of the defects or reaction products. Irradiations were performed under a variety of conditions and protons, deuterons and alpha particles were used. Energies ranged from 0.7 MeV to 1.8 MeV. Target materials were diamond, graphite, silicon carbide, and tektite glass. Author (TAB)

**N69-13576** Stanford Research Inst., Menlo Park, Calif. Low Temperature Physics Dept.
**FLUCTUATIONS IN SUPERCONDUCTORS**
William S. Goree, ed. and Frank Chilton, ed. May 1968 399 p refs Proc. Presented at the Asilomar Conf. Grounds, Pacific Grove, Calif., 13–15 Mar. 1968
(Contract N00014-67-C-0393)
(AD-672370) Avail: CFSTI CSCL 20/12

The theoretical and experimental state-of-the-art of fluctuations in superconductors is discussed in the conference papers presented. Attention is centered mainly on thermodynamic fluctuations, collective modes, flux flow fluctuations, modes of junctions, and critical point fluctuations. For individual titles, see N69-13576 through N69-13608.

**N69-13577** Stanford Univ., Calif.
**INTRODUCTION TO THE GENERAL THEORY OF THERMODYNAMIC FLUCTUATIONS**
W. A. Little *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 3–46 refs (See N69-13576 03-26)
Avail: CFSTI

A detailed kinetic theory of Brownian motion is presented, and the normalization of the correlation function is determined from the details of the microscopic collisions which constitute the noise process. The Langevin method of fluctuating forces is described, whereby such detailed study of microscopic processes may be circumvented by requiring that the normalization of the correlation function be such that the equipartition function is satisfied. A fluctuation-dissipation theorem is derived which reduces the fluctuation problem to that of determining the frequency and wave number dependent conductivity function. For density fluctuations, the conductivity formula suffices because of the continuity equation which expresses a conservation law rigorously relating the density and velocity fluctuations. In this relationship no Langevin forces can enter so that the fluctuations in the velocity spectrum determine completely the fluctuations in the density, regardless of how many dissipative coefficients occur in the hydrodynamic equations. It is pointed out that the fluctuation spectrum can be characterized by such parameters as the locations and residues of the poles. M.G.J.

**N69-13578** British Columbia Univ., Vancouver. Dept. of Physics.
**THERMODYNAMIC FLUCTUATIONS IN SUPERCONDUCTORS**
Ronald E. Burgess *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 47–82 (See N69-13576 03-26)
Avail: CFSTI

The Ginzburg–Landau model is used in considering some basic relations governing electromagnetic and order-parameter fluctuations. The cases examined cover fluctuations in a superconducting ring, magnetic fluctuations of a superconducting body in terms of the magnetic moment, coupled superconductors, a superconducting ring with a weak link, the Langevin approach to fluctuations of order parameter, and additional fluctuations in the presence of a persistent current. Attention is focused on the mean square fluctuation of the variables and their spectral distribution. In certain cases, the macroscopic variables have moments consistent with equipartition theorem even in the nonlinear cases involving the free energy in the Ginzburg–Landau theory or the Josephson coupling energy as a function of the phase. The method of calculating fluctuations from a parabolic expansion of the free energy about equilibrium is found to be conditionally acceptable for determining fluctuation of the magnitude or phase difference of $\psi$. The two-fluid description proves useful in showing the contribution of the kinetic energy of the normal fluid to the total energy, and the difference between the superfluid current and the total current in a superconductor. M.G.J.

**N69-13579** Carnegie-Mellon Univ., Pittsburgh, Pa.
**SUPERCONDUCTIVITY IN NARROW CHANNELS**
J. S. Langer *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 83–99 refs Sponsored in part by NSF (See N69-13576 03-26)
Avail: CFSTI

A phenomenological theory on the onset of resistance in very narrow superconducting channels is discussed. The principal point is that a state of nonzero superflow is truly metastable (as opposed to stable) in the sense that there always exists a finite probability for transitions to states of lower current and lower free energy. The supposition is made that there can occur in the superconductor large and highly improbable fluctuations which will nucleate dissipative transitions. A slightly generalized version of the Ginzburg–Landau theory is hypothesized to determine these fluctuations. It is assumed: (1) All relevant states of the system can be described by a complex-valued order parameter, $\psi(r)$. (2) The a priori probability that the system will be found in the state described by $\psi(r)$ is proportional to a Boltzmann factor. The main idea of the calculation is discussed, and the results are summarized. Fundamental questions regarding the validity of this calculation are raised, and attempts to provide a more rigorous basis for the phenomenological model are discussed. M.G.J.

**N69-13580** California Univ., San Diego. Dept. of Physics.
**OBSERVATIONS OF THE SPONTANEOUS TRANSITION OF A SUPERCONDUCTING RING BETWEEN STATES OF DIFFERENT FLUX QUANTA**

J. E. Lukens and J. M. Goodkind *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 101–102 (See N69-13576 03-26)
Avail: CFSTI

Observations show that a superconducting tin ring (3/16" diameter) with zero average current undergoes apparently spontaneous transitions between states in which the magnetic flux linking the ring differs by integral multiples of a flux quantum. Measurements were made of the rate at which these transitions occur as a function of temperature and of the critical current of the ring. All measurements were made by observing the flux linking the ring which is inductively coupled to a quantum flux detector through a superconducting transformer. There are no leads attached to the ring. The transformer is outside a copper can that encloses the ring which is temperature regulated to $10^{-5}$°K during the measurement. Author

**N69-13581** Pennsylvania Univ., Philadelphia. Dept. of Physics.
**QUASI-PARTICLE AND COLLECTIVE EXCITATIONS**
D. J. Scalapino *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 103–120 Sponsored in part by NSF (See N69-13576 03-26)
Avail: CFSTI

As the power spectrum of fluctuations depends directly on the quasi-particle scattering and collective states of the system, attention is focused on the spectral properties of these excitations and their relation to fluctuations in superconductors. An equation is derived to define the power spectrum $P(\omega)$ of the fluctuations of a dynamic variable A; in principle, a determination must be made of the probability that the $n^{th}$ state is excited $\rho_n$, the strengths of the matrix elements $(m/A/n)$, and the excitation energies $\omega_{mn}$ to obtain $P(\omega)$. The plasma-like collective excitations are mathematically described. The case of a finite superconductor is considered, and some results for plasma-like fluctuations in a wire are examined. Figures are included depicting the power spectrum of quasi-particle current fluctuations, the Josephson plasma frequency of a Sn–Sn junction versus Josephson dc current for various reduced temperatures, and the power spectrum $P_\phi(\omega)$ of the relative phase fluctuations between the ends of the wire illustrating the shift of the weight to lower frequencies as the temperature increases towards $T_c$. M.G.J.

**N69-13582** California Univ., Irvine. Dept. of Physics.
**LINEWIDTH OF JOSEPHSON RADIATION**
W. H. Parker *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 121–135 refs (See N69-13576 03-26)
Avail: CFSTI

A microwave detector was used to measure the linewidth of the radiation emitted by a Josephson superconducting tunnel junction. It was found that, for both Sn–I–Sn and Pb–I–Pb Josephson junctions biased to radiate at $10^{10}$ Hz, the linewidth of the emitted radiation depends on the dynamic resistance of the junction at the bias voltage and the temperature. At low temperature and dynamic resistance, the linewidth is often less than the 1 kHz resolution of the detector implying a spectral purity of better than 1 part in $10^7$. At temperatures greater than $T/T_c = 0.8$, the linewidth begins to increase rapidly with temperature until at $T/T_c = 0.98$, the linewidth has reached 10 MHz. Some ideas as to what to expect for the order of magnitude and functional dependences of the linewidth are developed. The results indicate: (1) The radiation linewidth can be described by an equation containing one term proportional to $R_D$ and another proportional to $R^2_D$. Any inherent radiation linewidth independent of the dynamic resistance is smaller than 1 kHz for a 10 GHz center frequency. (2) The term proportional to $R^2_D$ can be explained to within a factor of two by shot noise from the normal current. M.G.J.

**N69-13583** Pennsylvania Univ., Philadelphia. Dept. of Physics.
**OBSERVATION OF THE JOSEPHSON PLASMA OSCILLATION**
A. J. Dahm *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 137–140 refs (See N69-13576 03-26)
Avail: CFSTI

Resonance was observed by two techniques. In the small signal limit the second harmonic RF voltage generated by the junction was plotted as a function of DC current. Resonences were observed when $\omega_J$ was equal to the fundamental frequency of the microwaves irradiating the junction or to the second harmonic of this frequency emitted from the junction. The plasma frequency is observed to have the temperature and magnetic field dependence predicted by theory. The Q of the resonance was on the order of 100 and decreased with increasing temperature. For the large signal limit, the resonance was observed by plotting the DC Josephson current as a function of RF foltage. The increase in RF voltage in the junction at resonance causes singularities in the Josephson current RF voltage plane. This plasma oscillation involves an exchange of energy between the electric field across the barrier and the coupling energy of the system. The plasma frequency is obtained from the Hamiltonian for the system with the external circuit included. It is shown that the independent variable representing the external circuit is the phase and not the current. Author

**N69-13584** Rochester Univ., N. Y. Dept. of Physics and Astronomy.
**FLUCTUATIONS IN ONE AND TWO DIMENSIONAL SUPERCONDUCTORS**
R. D. Parks *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 141–158 refs (See N69-13576 03-26)
Avail: CFSTI

Serious experimental and data analysis problems associated with experiments on fluctuations in superconducting microbridges and whiskers are assessed. Particular attention is centered on the problem of determining the reduction in the superconducting transition temperature $\Delta T_c$ from the resistive behavior of microbridges or whiskers. Two methods used for determining $\Delta T_c$ are critically discussed: (1) The straight-forward approach compares the transition temperature of the thin film microbridge with that of the macroscopic patches of the same thin film located at the ends of the microbridge. This is obtained from the resistance vs. temperature curves of the composite samples. (2) The other method determinas $\Delta T_c$ in a self-consistent manner from the temperature dependence of the critical current. The theoretical situation is reviewed, and the inconsistencies and limitations in the various models are noted. The suggestion is made that whisker experiments should be abandoned in favor of microbridge experiments using the straight-forward method of determining $\Delta T_c$; however, new sample preparation techniques would be required to eliminate substrate effects. M.G.J.

**N69-13585** Cornell Univ., Ithaca, N. Y.
**DETERMINATION OF $T_c$ FROM RESISTANCE MEASUREMENTS**
W. W. Webb *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 159–161 (See N69-13576 03-26)
Avail: CFSTI

Another viewpoint is offered on the opinion that the error in the determination of the mean field critical temperature $T_c$ in measurements of the resistive transition of thin superconductors is so large that no finite upper bound can be put on the parameter $\Delta T_c$ to characterize the region of the supercurrent depression. The main problem is seen as one of identifying the mean field critical current curve and the critical temperature in the absence of fluctuations by using critical current data at temperatures far

enough from $T_c$ that fluctuation effects are negligible. Experimental procedures are outlined, along with methods of comparing tentative determinations of mean field critical currents with calculated values and electron microscopy measurements. The uncertainties involved in overestimating or underestimating $\Delta T_c$ are discussed, and it is suggested that the situation may be improved by better measurements of $a$ and an understanding of behavior close to the mean field lines. M.G.J.

**N69-13586** Stanford Univ., Calif. Dept. of Physics.
**VORTEX MODES IN TYPE-2 SUPERCONDUCTORS**
Alexander L. Fetter *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 163–165 refs (See N69-13576 03-26)
Avail: CFSTI

In the mixed state of a type-2 superconductor, a regular array of quantized flux lines penetrates the sample. This periodic structure can support a great variety of oscillatory modes, corresponding to waves propagating at arbitrary angles with respect to the applied magnetic field. Although a completely unified treatment is not possible at present, a simple description can be given in two distinct limiting cases: (1) For an extreme type-2 superconductor ($k >> 1$) in low and intermediate fields ($H_{c1} \leq H << H_{c2}$), the magnitude of the order parameter is constant almost everywhere, and the London theory becomes appropriate. This hydrodynamic model treats the mixed state as an incompressible nonviscous charged fluid containing quantized vortices. (2) In high fields ($H \leq H_{c2}$), the magnitude of the order parameter $|\Delta|$ is reduced relative to its value $\Delta_0$ in zero field, so that the ratio $|\Delta|/\Delta_0$ serves as an expansion parameter. Hence nonlinear effects are small. The fluctuations of $\Delta$ have been treated in two different ways, one based on the microscopic theory and the other based on the Ginzburg–Landau theory. Author

**N69-13587** Aeronutronic, Newport Beach, Calif.
**PHASE FLUCTUATIONS IN SUPERCONDUCTORS**
R. E. Eck, M. Nisenoff, B. T. Ulrich, and J. E. Mercereau *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 187–189 refs (See N69-13576 03-26)
Avail: CFSTI

Several experiments are described to show the effect of dissipation or fluctuation in a process which is normally considered to be superconducting. A series of equations are derived and integrated between two points within a superconductor to find a formula relating the time rate of change of relative phase to the relative free energy; the experiments are based on this formula. In the first experiment the phase is driven, generating a potential difference; this occurs when a superconductor is connected to a current source. In the second experiment, a difference in potential is established and phase precession occurs. This is experimentally achieved by driving the superconductor from a voltage source. The third experiment involves measurements of the intrinsic fluctuations in the superconductor itself. This was performed by using a superconducting interferometer to actually measure the time-dependent phase fluctuations in a superconducting specimen. M.G.J.

**N69-13588** Aeronutronic, Newport Beach, Calif.
**SIZE OF VORTICES INVOLVED IN FLUX FLOW ACROSS TYPE 1 SUPERCONDUCTING FILM RINGS**
M. Nisenoff *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 191 (See N69-13576 03-26)
Avail: CFSTI

Summary information is presented on the periodic behavior of the voltage associated with the flux flow phenomena as a function of the applied low frequency flux. This periodicity was measured and found to be h/2e to an accuracy of 1/2%. Author

**N69-13589** Stanford Research Inst., Menlo Park, Calif. Low Temperature Physics Dept.
**FLUX FLOW NOISE**
Frank Chilton *In its* Fluctuations in Superconductors May 1968 p 193–207 refs (See N69-13576 03-26)
Avail: CFSTI

The importance of distinguishing between stochastic and deterministic noise in flux flow is stressed, along with the necessity of obtaining enough information from measurements to separate the stochastic from the deterministic noise. Two types of models constructed to describe noise are described: (1) the kinetic or microscopic models used to calculate noise from the dynamics of the elemental charge carriers, etc., and (2) the thermodynamic models based on general principles. Although both types of models have some relevance for flux flow, any unique physical aspects of flux flow are more apparent in kinetic models. The experimental results show that the most striking features of flux flow noise is its largeness. From laboratory measurements on foils and thin films, it is concluded that under conditions of partial flux flow the noise is less than 10 times Johnson noise and is buried in the resolution of the instrumentation. At higher current in the full flux flow region, the noise is greater than 100 times Johnson noise. M.G.J.

**N69-13590** Philips Gloeilampenfabrieken N. V., Eindhoven (Netherlands). Philips Research Labs.
**FLUX TRANSPORT NOISE IN SUPERCONDUCTORS**
G. J. Van Gurp and D. J. Van Ooijen *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 209–225 refs (See N69-13576 03-26)
Avail: CFSTI

Equations are derived to determine the flux flow noise, flux modulation noise, and flicker noise in type 2 superconductors. The flux flow noise was calculated on the assumption of identical, independent voltage pulses generated at random. It is considered likely that there is a distribution of pulse heights and pulse durations so that not all pulses are identical. It is also found that the flux motion is not completely independent; the interaction of moving bundles with pinning centers generates modulation noise. The generation of the voltage pulses might not be entirely random due to correlation between successive bundles created at the same place. A comparison between flux flow noise in type 1 and type 2 superconductors shows differences in the scale of the structure and its immobility in high fields. Data are included on the mean square noise voltage on a hollow tin cylinder measured as a function of temperature. The value is calculated on the assumption of random entry of a single quanta. M.G.J.

**N69-13591** California Univ., Berkeley. Lawrence Radiation Lab. Dept. of Physics.
**FLUXJUMPING IN TYPE 2 SUPERCONDUCTORS**
G. I. Rochlin *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 227–230 (See N69-13576 03-26)
Avail: CFSTI

The distribution of bundle sizes was measured for flux bundles entering long thin cylinders of Pb + 2 atomic % In alloys ($K \approx 1.2$) in a slowly varying axial magnetic field at 4.2°K. The bundles enter in discrete jumps whose total flux is given by $\phi = n\phi_0$, where $\phi_0$ is the fluxoid, $\approx 2 \times 10^{-7}$ gauss–cm$^2$. At any given magnetic field, H, the distribution of jump sizes was found to be of the form $N(\phi) = N(0) \exp(-\phi/\phi)$ where $N(\phi)$ is the number of jumps whose flux lies between $\phi$ and $\phi + \Delta\phi$. Both $\phi$, defined as the mean jump size, and N(0), the extrapolated zero intercept, are strongly dependent on H. A sweep of $\approx 10$ Oe/sec was used, but the distribution was unaffected when the rate was changed by a factor of 10. Author

**N69-13592** California Univ., Berkeley. Dept. of Physics.
**A GENERAL EXPRESSION FOR THE POWER SPECTRUM OF STOCHASTIC PULSE SEQUENCES WITH APPLICATION TO NOISE IN TYPE 2 SUPERCONDUCTORS**
Cristoph Heiden *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 231-238 refs (See N69-13576 03-26)
(Grant AF-AFOSR-68-1362)
Avail: CFSTI

Some results are presented on the measurement of power spectra of flux jumps, which were produced by magnetizing a type 2 superconductor in a linearly varying magnetic field. An alloy of Pb-2 at. % In was used for the specimens, which were cylindrical in form. The flux jumps produced voltage pulses in a small pick-up coil surrounding the specimen, and the power spectrum of these voltage pulses was measured. Author

**N69-13593** Maryland Univ., College Park. Dept. of Physics and Astronomy.
**FLUCTUATIONS AND THE APPROACH TO THE SUPERCONDUCTING TRANSITION FROM ABOVE: PARACONDUCTIVITY AND THE CRITICAL REGION**
Richard A. Ferrell *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 239-249 refs Sponsored in part by NSF (See N69-13576 03-26)
Avail: CFSTI

A calculation is described which introduces fluctuations into the Landau-Ginzburg theory, and which leads to conclusions which differ quantitatively from the qualitative observation that a short electron mean-free path will tend to make more evident the effect of fluctuations on the behavior of a superconductor near its phase transition. The equations derived demonstrate that the temperature width is identical to the estimate arrived at by using the Ginzburg criterion. This criterion refers to the approach from below the transition and state that the critical region is entered when the mean square fluctuations in the order parameter, in a volume of the size of the correlation length, become as large as the square of the mean order parameter averaged over this volume. It is noted that the renormalization is a larger effect depending on the total fluctuations which exist at all wave numbers less than $r_0$. It is pointed out that in a superconducting film the fluctuations have to be treated two-dimensionally when the correlation length becomes larger than the film thickness; this greatly increases the temperature width of the critical region. M.G.J.

**N69-13594** Ford Motor Co., Dearborn, Mich. Scientific Lab.
**FLUCTUATIONS IN NARROW THIN FILM SUPERCONDUCTORS**
T. K. Hunt *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 251-254 refs (See N69-13576 03-26)
Avail: CFSTI

An overview of experimental data is presented on the superconducting transition temperature of very narrow thin film strips of tin. It was found in some experiments that the dependence of $\Delta T_c$ on sample dimensions was in good agreement with theory but extraneous noise fed into the sample system from external circuitry led to effective noise temperatures of the order of 20° K well above the bath temperature. An experiment is reported in which low resistance helium temperature shunts were used to effectively eliminate the extraneous noise. When this precaution is taken, it was found that the data show excellent agreement with the results of a simple analysis in which no parameters need to be adjusted. M.G.J.

**N69-13595** International Business Machines Corp., Yorktown Heights, N. Y. Watson Research Center.
**SUPERFLUIDITY AND LONG RANGE ORDER IN TWO DIMENSIONAL SYSTEMS**
Gordon Lasher *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 255-257 refs (See N69-13576 03-26)
Avail: CFSTI

Equations which cast doubt on the existence of superfluidity in two dimensions are reviewed. To show that two-dimensional systems can be superfluid, the density matrix is expressed as a multiple integral over the phases of coherent phonon states in analogy to Glauber's treatment of the optical radiation field. The point of using this representation is that the matrix element can be shown to factor into two functions which are well-defined in the infinite volume limit. The existence of this wave function can be used in the usual argument for superfluidity. Author

**N69-13596** Cornell Univ., Ithaca, N. Y.
**STAGE STEPS IN THE RESISTIVE TRANSITIONS OF SUPERCONDUCTING MICROCRYSTALS**
W. Webb *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 259 (See N69-13576 03-26)
Avail: CFSTI

A brief report is presented on some voltage steps observed in the resistive transitions of tin whisker crystals. Their properties are similar to phenomena reported on aluminum bridges. Author

**N69-13597** California Univ., Berkeley. Lawrence Radiation Lab.
**NOISE ON CONSTANT CURRENT STEPS IN ALUMINUM MICROBRIDGES**
G. I. Rochlin *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 261-263 refs (See N69-13576 03-26)
Avail: CFSTI

Observational data are preported of noise on the I-V characteristics of thin film microbridges in the resistive region near the superconducting transition. The experiments were performed on the dirtiest possible system, aluminum microbridges deposited at $\approx 10$Å/sec at $10^{-6}$ torr. Typical bridges were formed by evaporating onto a glass slide over a filament of Duco cement which had been slit by a scalpel. Resistive transitions were usually spread over the region between 1.30° and 1.43°K; temperatures were stabilized to within $4 \pm 10^{-5}$°K. To examine the character of the switching, power spectra were taken at the center of the steps. It was found that the spectrum usually consisted of an $f^{-2}$ noise power at high frequency superimposed on a series of very narrow harmonically spaced spikes. Other observations include: (1) External reactances do not shift the switching frequency. (2) As the samples are immersed in liquid helium well below the $\lambda$ point, nucleate boiling seems unlikely. (3) The steps and the spectra are reproducible after cycling to 77°K. M.G.J.

**N69-13598** Massachusetts Inst. of Tech., Cambridge.
**COLLECTIVE OSCILLATIONS IN A JOSEPHSON JUNCTION**
M. J. Stephen *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 265-275 refs (See N69-13576 03-26)
Avail: CFSTI

The electric and magnetic properties of junctions much larger than the Josephson penetration depth are defined. The propagation of waves in these structures is discussed, and the effect of thermal fluctuations on various properties is considered. Author

**N69-13599** Minnesota Univ., Minneapolis. School of Physics and Astronomy.
**EXPERIMENTAL STUDIES OF LONG JOSEPHSON JUNCTIONS**

A. M. Goldman *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 277–283 refs (See N69-13576 03-26)
(Contract AT(11-1)-1569)
Avail: CFSTI

Some preliminary results and conclusions are reported regarding unusual features of the finite voltage parts of the current–voltage (I–V) characteristics of strongly coupled junctions. These include: (1) An infinite slope segment in the finite voltage I–V characteristics was observed in long superconducting junctions. The continuous variation with the applied magnetic field of the voltage at which the anomaly occurs suggests that it is not a self-induced step. (2) The remarkable agreement of the dependence of the ratio V/H on the magnetic field, with the dependence of the same ratio computed for the finite voltage mixed state–Meissner state transition, suggests that the anomaly may be associated with this transition. M.G.J.

**N69-13600** California Univ., Berkeley. Dept. of Physics.
**THE MAGNETIC FIELD DEPENDENCE OF THE CRITICAL CURRENT IN A SELF-FIELD LIMITED JUNCTION**
John Clarke *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 285–286 ref (See N69-13576 03-26)
Avail: CFSTI

An experimental result is given which verifies the theory for the magnetic field dependence of the critical current of a junction which is self-field limited. It is shown that as the field is increased from zero, the critical current decreases linearly until flux completely penetrates the junction, after which the usual Fraunhofer-type pattern is observed. As the field is reduced again, the oscillatory behavior persists to a somewhat lower value, corresponding to flux trapping in the barrier. Author

**N69-13601** Brown Univ., Providence, R. I.
**COMMENT ON JUNCTIONS WITH METALLIC BARRIERS**
Alexis Baratoff *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 287–289 refs (See N69-13576 03-26)
Avail: CFSTI

Experiments have shown that both insulating junctions and metallic pooint contacts exhibit a Josephson-like dc current-phase characteristic, an attempt was made to understand when a contact behaves in this manner. The following extreme situation was studied: a superconductor containing a region of thickness with an increased impurity content and, hence, reduced coherence length. This corresponds to a strong coupling contact. One-dimensional solutions of the Ginzburg–Landau equations were investigated ignoring Meissner screening (uniform current density perpendicular to the barrier). This would be a realistic model of sufficiently narrow point contacts or short superconducting bridges. The phase change is obtained by integrating the inverse square of the normalized order parameter between limits chosen to simulate the effect of screening currents on both sides of the contact. Author

**N69-13602** Aeronutronic, Newport Beach, Calif.
**EFFECTS OF FLUCTUATIONS ON JUNCTION CHARACTERISTICS**
L. Vant-Hull *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 291–302 refs (See N69-13576 03-26)
Avail: CFSTI

Consideration is given to the case of two superconductors coupled by electron tunneling. If the barrier is thick enough, essentially no tunneling of pairs will occur so n (pairs) remain fixed for each superconductor and the relative phases of the superconductors are undefined. As in the case of superconducting filaments, the thermal energy corresponding to a single degree of freedom is associated with correlation of the phases across the barrier. Examples of actual junction behavior are given, along with laboratory observations of the significant influences on I-V characteristics from electromagnetic radiation over most of the radio spectrum at levels occasionally as low as $10^{-13}$ watts/root cycle. It is pointed out how averaging due to noise currents can round off I–V curves making the zero voltage currents unobservable. Details are given on an experimental arrangement involving double junctions where the geometry of the sample makes the effects of the Josephson currents inherently visible in the face of overwhelming fluctuations (a 1.3 meter quantum interferometer). It was found that the application of overwhelming noise to a quantum system does not necessarily destroy the quantum effects. M.G.J.

**N69-13603** Philco-Ford Corp., Newport Beach, Calif. Aeronutronic Div.
**DYNAMICS OF PHASE FLUCTUATIONS IN WEAKLY-CONNECTED SUPERCONDUCTORS**
James Z. Zimmerman *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 303–304 refs (See N69-13576 03-26)
(Contract N00014-68-C-0138)
Avail: CFSTI

Attention is centered on the way in which voltage (and therefore phase) fluctuations appear in a weakly-connected superconductor as a consequence of electromagnetic contact with its environment. It is assumed that the superconductor is in thermal equilibrium with the environment. For quantitative description, the simplest case is that of a superconducting weak link connected in parallel with a resistance; a more difficult case is that of a weakly-connected superconducting loop inductively coupled to a normal conducting environment. Author

**N69-13604** Bell Telephone Labs., Inc., Murray Hill, N. J.
**CRITICAL PHENOMENA AND THEIR BEARING ON THE SUPERCONDUCTING TRANSITION**
P. C. Hohenberg *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 305–337 refs (See N69-13576 03-26)
Avail: CFSTI

Various quantitative criteria, proposed for the breakdown of meanfield or Landau theories are discussed in the context of determining which ones might lead to observable effects. The thermodynamic properties and long-range correlations of second order phase transitions are described briefly, and the contrast between classical and critical behavior is pointed out. The ferromagnet is used as a prototype. In describing the criteria for the breakdown of mean-field theory, equilibrium and transport properties are treated separately. An assessment is made of available experimental data. Author

**N69-13605** Cambridge Univ. (England). Cavendish Lab.
**CRITICAL PHENOMENA IN SUPERFLUIDS**
B. D. Josephson *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 339–342 refs (See N69-13576 03-26)
Avail: CFSTI

The superfluid transition is a particular example of the critical phenomenon. To make a detailed comparison of the superfluid transition and other critical phenomena is difficult, since no experiments to measure the superfluid order parameter have yet been carried out. It is known, however, that the transition is associated with a logarithmic specific heat singularity, similar to that observed in other second-order phase transitions. The quantities which can be measured in superfluids are the ones associated with the transport of matter and heat, which in the hydrodynamic limit is governed by two-fluid hydrodynamics. By utilizing the fact that

the phase of the order parameter is also the velocity potential for superfluid flow, it is possible to make use of the scaling law ideas developed for other critical phenomena. Author

**N69-13606** Chicago Univ., Ill. James Franck Inst.
**CRITICAL POINT FLUCTUATIONS IN SUPERFLUIDS**
J. A. Tyson *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 343–354 refs (See N69-13576 03-26)
Avail: CFSTI

An overview is presented on the use of static scaling laws in the critical region near $T_\lambda$. The coherence length, a unique, critically temperature-dependent parameter, is the basis for this exponential scaling behavior. Figures are included to depict the behavior imagined for the real-space single-particle correlation function at T=0, possessing a coherence length of atomic dimensions; and to show the three basic regions for $T<T_\lambda$. Details are given on experiments using second sound which show the validity of the hydrodynamic approximation in the macroscopic critical region. Relations for second sound velocity and attenuation, valid in the hydrodynamic limit and for T near $T_\lambda$ are derived. From the velocity–temperature data and the superfluid density data, the hydrodynamic relation was inverted and $C_p(T)$ was obtained by solving an integral equation. The resulting specific heat data were found to be very sensitive to velocity changes. As a further test, the linewidth was measured as a function of temperature, frequency, power, and time to determine the attenuation in a macroscopic critical region. M.G.J.

**N69-13607** Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics.
**DECAY OF PERSISTENT CURRENTS IN SUPERFLUID HELIUM**
John D. Reppy *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 355–356 refs Sponsored in part by NSF (See N69-13576 03-26)
Avail: CFSTI

Summary information is presented on an experiment which is being conducted to investigate a fluctuation theory which predicts that a super-current flowing in an annular container should decay with a slow logarithmic time dependence. It is reported that the logarithmic decay was observed for a number of persistent currents formed in an annular container filled with a 500 Å pore filter material. Author

**N69-13608** Cornell Univ., Ithaca, N. Y. Baker Lab.
**THE DECAY OF SUPERFLOW IN HELIUM**
Michael E. Fisher *In* Stanford Res. Inst. Fluctuations in Superconductors May 1968 p 357–380 refs (See N69-13576 03-26)
Avail: CFSTI

The time dependence of the superfluid flow is discussed from a fairly general theoretical viewpoint. It is shown that the logarithmic dependence on time follows from the basic kinetic equation governing the change of the mean superfluid velocity, $v_s$. The kinetic equation is derived and solved in terms of the fundamental barrier function $r(v_s)$ and other parameters. The nature of the fluctuation step is considered to obtain the magnitude of the change in $v_s$ associated with each step; this leads to agreement with the observed decay rates. The driving free energy is estimated and shown to be effectively infinite in most circumstances. The barrier free energy and, hence, the critical velocity $v_c$ are also estimated. The predicted dependence of $v_c$ on temperature is in agreement with observation but the predicted magnitude is too large by a factor of order 5. Possible reasons for this discrepancy are examined, and a calculation is made which allows for microscopic nonuniformities in the flow. Author

**N69-13636#** Kernforschungsanlage, Juelich (West Germany).
**THE SATURATION PHENOMENON OF DEFECT PRODUCTION DURING ELECTRON BOMBARDMENT OF COPPER [DIE SAETTIGUNGSERSCHEINUNG DER DEFEKTPRODUKTION BEI ELECKTRONENBESTRAHLUNG VON KUPFER]**
Hans Schustor Jun. 1968 118 p In GERMAN
(JUL-541-FN) Avail: CFSTI

The behavior of the damage rate of copper, i.e. the increase in the atomic Frenkel pair concentration per flux density unit, was investigated as a function of increasing defect concentration during irradiation with 3 MeV electrons. The pure copper samples were at temperatures below 9°K during irradiation. Details of the experimental arrangement and the production and properties of the samples are given. The effects of the experimental techniques on the measurements, due especially to the use of high-energy electrons, are considered. The results are compared with those obtained during bombardment with neutrons, deuterons, and $\alpha$ particles. Transl. by K.W.

**N69-13688#** Battelle Memorial Inst., Columbus, Ohio.
**INVESTIGATION OF THE COMPRESSIBILITY OF LiF BY HIGH-PRESSURE HIGH-TEMPERATURE X-RAY DIFFRACTION METHODS Final Report, 19 Dec. 1967–15 Jul. 1968**
Lynn C. Carrison and Charles B. Sclar Sep. 1968 19 p refs
(Contract F19628-68-C-0123)
(AD-676280; AFCRL-68-0441) Avail: CFSTI CSCL 20/2

Measurements were made of the compressibility of LiF to 60 kilobars over the temperature range from 25 to 600C by high-pressure high-temperature X-ray powder diffraction methods. Pressures were determined by using NaCl as an internal calibrant. These results also provide data on the thermal expansion of LiF between 25 and 600C at pressures of 38 and 57 kilobars. The feasibility of determining the unit-cell volume of crystalline solids under extreme pressure and temperatures by in situ X-ray methods has been demonstrated. Author (TAB)

**N69-13689#** Massachusetts Inst. of Tech., Cambridge. Center for Materials Science and Engineering.
**CONCENTRATION DEPENDENT INTERDIFFUSION IN THE LEAD CHALCOGENIDES**
Robert William Brodersen Oct. 1968 51 p refs
(Contract N00014-67-A-0204-0010)
(AD-676910; TR-1) Avail: CFSTI CSCL 20/12

The depth of p-n junctions in the lead chalcogenides has been calculated by using different diffusion coefficients for the n and p-type material in solving the interdiffusion problem. The solutions to the diffusion equation using a step-function model have been obtained for two cases of one-dimensional geometry; the semi-infinite solid and the slab of finite thickness. The results are useful in predicting the movement of p-n junctions, in determining the equilibration time required for obtaining homogeneous material and in predicting concentration profiles. Author (TAB)

**N69-13694#** Stanford Univ., Calif. Microwave Lab.
**SPECTROSCOPIC STUDIES OF $SrTiO_3$ USING IMPURITY ION PROBES**
S. E. Stokowski May 1968 121 p refs
(Contract DA-31-124-ARO-D-208)
(AD-676851; ML-1640) Avail: CFSTI CSCL 20/12

Studies were made of the properties of SrTiO3 using the impurity ions Cr(3+) and Mn(4+) as probes. Sharp line fluorescence and absorption in the region of 7930A were observed in Cr(3+) doped and undoped SrTiO3. Fluorescence from Mn(4+) doped SrTiO3 was also seen at about 7230A. At low temperatures a temperature dependent splitting of the R-line transition of Cr(3+) is seen. It is shown that this is due to the lifting of the degeneracy

of the (2)E state by the temperature dependent tetragonal field present in SrTiO3 below 107K. Very unusual and large shifts of the R-lines of Cr(3+) with temperature and applied electric fields were observed. The shifts were found to be proportional to the reciprocal dielectric constant of SrTiO3. The electric field shift is explained in terms of the ionic polarization induced by the electric field. Calculations were made for MgO and SrTiO3 of the possibility of increasing the Cr(3+) R-line transition probability by means of an applied electric field. The possible effect is too small in MgO to be observed experimentally. TAB

N69-13713# Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Physics.
**THE LOW TEMPERATURE MAGNETIZATION OF COPPER NITRATE HYDRATE**
B. E. Myers, L. Berger, and S. A. Friedberg. Oct. 1968 12 p refs Submitted for publication
(Contract Nonr-760(26))
(AD-676310; TR-12) Avail: CFSTI CSCL 20/12

Magnetization isotherms were measured for single crystals of monoclinic Cu(NO3)2.2.5H2O between 1.2 degrees and 4.2 degrees K by a ballistic method. Fields up to 43 kOe were applied along the b-axis, i.e. the long axis of the needlelike specimens. The character of the M vs. H curves changes rapidly in this temperature interval. They are described in first approximation by a model of this salt in which Cu++ ions are coupled by isotropic antiferromagnetic exchange, -JS sub 1.S sub 2, in isolated pairs. The best fit of the data with the isolated cluster model yields J = 5.23 k and g = 2.23, in reasonable agreement with earlier susceptibility, specific heat and proton resonance results. Several modifications of the model were considered in order to remove small systematic discrepancies. The addition of a very weak intercluster coupling in a molecular field approximation yields a quantitative fit of all the data. If H = H sub o + nM, we find n = -1.2 mole/cgs while J = -5.14 k and g = 2.35, in even closer agreement with other observations. This weak antiferromagnetic coupling is large enough to explain the absence of hyperfine structure on paramagnetic resonances seen in the excited pair triplet state. Author (TAB)

N69-13722# Gulf General Atomic, Inc., San Diego, Calif.
**AB INITIO CALCULATION OF PHONON DISPERSION CURVES FOR BERYLLIUM**
J. U. Koppel (Ph.D. Thesis) Jul. 1968 167 p refs
(Contract AT(04-3)-167)
(GA-8745) Avail: CFSTI

Sham's method for calculating phonon dispersion curves in metals is generalized to nonprimitive lattices and applied to the case of beryllium which has the hexagonal closed-packed structure. Three effects contribute to the elements of the dynamical matrix which determines the phonon frequencies: (1) the direct Coulomb interaction between ions, (2) the short-range exchange repulsion between core electrons of neighboring ions, and (3) the strong screening action of the conduction electrons. The latter contribution is evaluated from a screened Hartree–Fock expression for the electronic ground-state energy in the distorted crystal. This energy is expanded up to second order in powers of the displacements of the ions from their equilibrium position. Numerical results are given for the beryllium band structure, dielectric matrix, and phonon dispersion curves. Energies and wave functions of the Bloch states are calculated by the orthogonalized plane waves method. Author

N69-13742# Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics.
**CRITICAL CURRENTS AND THE ONSET OF RESISTANCE IN SUPERCONDUCTORS**
Vinay Ambegaokar Oct. 1968 53 p refs Presented at NATA Advan. Study Inst. on Superconductivity, Montreal, Jun. 1968
(Contract Nonr-401(38))
(AD-676900; TR-29) Avail: CFSTI CSCL 20/3

The report describes the intrinsic resistive transition in small pieces of superconducting material. Two recent theoretical approaches are described: a theory of the disappearance of resistance as T approaches T sub c (the transition temperature) from above; and a theory of the appearance of resistance in thin filaments as T approaches T sub c from below. Although the approaches mentioned appear to be, and indeed physically are, two ways of looking at the same phenomenon, the theories are quite distinct. Author (TAB)

N69-13808# Northrop Corp., Hawthorne, Calif.
**THE PROPERTIES OF DEFECTS INTRODUCED IN SILICON BY 10-MEV ELECTRON IRRADIATION Final Report, Jun. 1966–Apr. 1968**
Orlie L. Curtis, Jr., Ralph F. Bass, and Carl A. Germano Jun. 1968 78 p refs
(Contract AF 19(628)-6047)
(AD-676303; AFCRL-68-0368; NCL-68-37R) Avail: CFSTI CSCL 20/12

The family of silicon devices is ever increasing. However, silicon, being a semiconductor, is much more sensitive to lattice defects than the metal and insulating materials which are constituents of most devices. Because of the desire to use electronic systems in space (where there are important quantities of charged particles) and because of the need for military systems capable of operating in a weapons environment, radiation effects in silicon is a very important topic. A good deal of information has already been obtained about the effects of neutron irradiation on silicon. A determination of minority-carrier life-time at low excess densities was performed for a wide variety of starting materials. No dependence on manufacturer, oxygen concentration, or dislocation density was found for either n- or p-type material. Futhermore, with one possible exception (Al in p-type material) the nature of the dopant was unimportant. (The dopants used were As, P, Sb, Ga, B, and Al). These and subsequent studies of the dependence of lifetime upon excess carrier density (injection level) showed that much of the earlier confusion in degradation was caused by failure to consider the operation point of the devices tested. Author (TAB)

N69-13881# Lockheed Missile and Space Co., Palo Alto, Calif.
**RELATIVISTIC BAND STRUCTURE OF GeTe, SnTe, PbTe, PbSe, AND PbS**
Frank Herman, Richard L. Kortum, Irene B. Ortenburger, and John P. Van Dyke [1968] 47 p refs Presented at the Intern. Colloq. on 4–7 Semicond. Compds., Paris, 15–17 Jul. 1968 Submitted for publication
(Contracts AF 19(628)-5750; F33615-67-C-1793)
(AD-676299; LMSC-6-78-68-42) Avail: CFSTI CSCL 20/2

Relativistic OPW band calculations have been carried out at key points in the reduced zone for several IV-VI compounds. The band structure in the remainder of the zone has been filled in with the aid of an interpolation scheme. To our knowledge, these are the first fully relativistic first-principles band calculations for IV-VI compounds (in contrast to non-relativistic calculations supplemented by relativistic and spin-orbit coupling corrections). Our first-principles band calculations lead to physically realistic energy band models which are sufficiently accurate to account for most of the characteristic features of the experimental reflectivity spectra. It is difficult to interpret the electroreflectivity spectra unambiguously in terms of these band models but a number of plausible spectral assignments can be made. Refined energy band and optical spectrum calculations are in progress and will be reported elsewhere. Author (TAB)

# 27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

**N69-13723#** Stanford Research Inst., Menlo Park, Calif.
**IGNITION RESPONSE OF SOLID PROPELLANTS TO RADIATION AND CONDUCTION**
S. Henry Inami, Leonard Mc Culley, and Henry Wise 1 Oct. 1968 24 p refs
(Contract Nonr-3415(00))
(AD-676549) Avail: CFSTI CSCL 21/9.2

Experimental measurements were carried out on the ignition response of solid propellants to radiative and to conductive heat transfer. The propellants were composed of ammonium perchlorate and different organic binders. The experimental results were interpreted in terms of a model involving exothermic chemical reaction in the condensed phase of the propellant. The heat release rates in the surface-coupled reactions were measured independently. Such a model adequately fitted the ignition process associated with a thermal runaway in the condensed phase. A comparison of the ignition data demonstrated different response of the propellants to the mode of ignition. The importance of these results to rocket motor tests is discussed. Author (TAB)

**N69-13882#** Société pour l'Etude et la Réalisation d'Engins Balistiques, Courbevoie (France).
**IGNITION SYSTEMS OF A SOLID PROPELLANT MASS [SYSTEMES D'ALLUMAGE DE BLOCS DE PROPERGOL]**
F. Chanut 1968 14 p In FRENCH Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

Some ignition problems of propergol solid propellant rocket engines are reviewed and two warm gas ignition systems, the squib and the ignition tube, are examined. Their properties and their advantages and disadvantages are discussed and the results of some tests are given. ESRO

# 28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

**N69-12831*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**FOULING CHARACTERISTICS OF ASTM JET A FUEL WHEN HEATED TO 700°F IN A SIMULATED HEAT EXCHANGER TUBE**
James J. Watt, Albert Evans, Jr. and Robert R. Hibbard Washington Dec. 1968 29 p refs
(NASA-TN-D-4958) Avail: CFSTI CSCL 21D

Supersonic aircraft might profitably utilize the greater heat sink that would be made available if fuels could be heated to higher temperatures than is current practice. Therefore, the ASTM Jet A fuels were heated to 700°F (644 K) under simulated heat exchanger conditions. Tests were made with air-saturated and deoxygenated fuels at pressures ranging from 2.5 to 615 psia ($1.72 \times 10^4$ to $424 \times 10^4$ N/m$^2$ abs) for periods of 20 hours, and the amounts of tube surface fouling were determined. Very small amounts of solids collected on the surface in all cases; the accumulated solids represented from 0.05 to 2.5 ppm of the fuel. The deposits decreased markedly when the dissolved oxygen was removed from the fuel and, in general, decreased with increasing pressure. Author

**N69-13237*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PERFORMANCE INVESTIGATION OF BIPROPELLANT FRACTIONAL-POUND THRUSTERS**
R. J. Rollbuhler Washington Dec. 1968 24 p refs
(NASA-TM-X-1699) Avail: CFSTI CSCL 21H

The performance capabilities of four fractional-pound-thrust chemical bipropellant rocket thrusters were investigated experimentally. The thrusters were tested with hydrazine-type fuels and nitrogen tetroxide oxidizer in a vacuum of 0.5 to 3.0 torr. Data were obtained to calculate the performance parameters as functions of propellant mixture ratio. Maximum characteristic exhaust velocity ranged from 3400 to 3700 ft/sec (1038 to 1130 m/sec). Peak values of specific impulses varied from 155 to 245 sec. Operational difficulties increased with decreasing propellant injection orifice size (blockage). Hypergolic ignition did not present any problems. Instrumentation limitations prevented the obtaining of pulsing operation data. Author

**N69-13275*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**TEST OF IMPROVED IGNITER FOR FIRST STAGE SEPARATION ROCKETS FOR THE ATLAS-CENTAUR LAUNCH VEHICLE**
Richard W. Heath, Henry Synor, and Ralph F. Schmiedlin Washington Dec. 1968 12 p refs
(NASA-TM-X-1676) Avail: CFSTI CSCL 21H

During the course of the Atlas-Centaur separation tests, conducted at the Lewis Research Center, anomalies were discovered in the performance of the igniters that fire the Atlas retarding rockets. A new igniter was developed and tested to assess its marginality. The test results indicated that the new igniter possessed a sufficient margin of performance for flight operations. Author

**N69-13369** National Research Council of Canada, Ottawa (Ontario).
**A VECTORED THRUST POWERPLANT FOR COMMERCIAL V/STOL OPERATIONS: SYSTEM CONSIDERATIONS AND PRELIMINARY MODEL TESTS**
R. A. Tyler and R. G. Williamson [1968] 11 p refs Presented at 6th Congr. of the Intern. Council of the Aeron. Sci., Munich, 9–13 Sep. 1968
(ICAS-68-25) Avail: Issuing Activity CSCL 21E

VTOL capability promises increased potential for commercial short-haul aircraft. A variable bypass ratio lift/thrust engine arrangement is discussed in relation to safety and economic requirements. Some feasibility aspects and possible problem areas have been investigated on a model scaled to produce 700 lb. lift/thrust. The test results relate mainly to fan-drive efficiency at partial admission, and to the use of fan stator adjustment for fast response thrust modulation. Author

**N69-13380#** Imperial Metal Industries, Ltd., Kidderminster (England). Summerfield Research Station.
**APOGEE MOTORS FOR CETS COMMUNICATION SATELLITES**

M. Wortley and P. R. Barlow Apr. 1968 40 p refs Prepared for ELDO
Avail: CFSTI

Designs are described of solid propellant rocket motors suitable for use as apogee motors in the launching of geostationary communications satellites for CETS. An outline is given of the necessary development and qualification programs and costs. Two basic solutions are proposed, one with a high strength steel case, and the other with a glass reinforced plastic case. The propellant, which for both types of motor is bonded to the motor case by a layer of insulation, is composite-modified cast-double-base and delivers a specific impulse in vacuo of 2893 Ns/Kg. ESRO

**N69-13442*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**THE INFLUENCE OF THE INJECTION PROCESS ON THE OPERATING BEHAVIOR OF SMALL LIQUID ROCKETS. PART 1: HYDRODYNAMIC VARIABLES IN THE FUEL INJECTION BY IMPINGING JETS**
W. Hartung Feb. 1968 25 p refs Transl. into ENGLISH from the German Res. Rept.
(Contract NAS7-100)
(NASA-CR-97928; DLR-FB-68-17) Avail: CFSTI CSCL 21H

Cold flow studies on doublet and triplet impinging jets were conducted to define the major variables affecting the mixing and distribution of injected propellants. The well known criteria for optimum mixing of the doublet impinging jets is confirmed by an analytical model of the mixing process. Investigations on the triplet impinging jets show a similar relation for optimum mixing. But in this case the data indicate a clear effect of the included impingement angle. Author

**N69-13479*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**QUIET ENGINE DEFINITION PROGRAM. VOLUME 1: SUMMARY Final Report**
John H. Lewis, III 4 Oct. 1968 42 p
(Contract NAS3-10497)
(NASA-CR-72457-VOL-1; PWA-3516-VOL-1) Avail: CFSTI CSCL 21E

The Quiet Engine Definition Program has defined a study engine whose noise is substantially reduced from the level of current commercial transport powerplants. The resultant Quiet Engine configuration evolved from a series of three tasks which narrowed the selection by stages from a broad parametric study, through four candidate engines to a final detailed design. Author

**N69-13480*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**QUIET ENGINE DEFINITION PROGRAM. VOLUME 2: TASK 1 Final Report**
John H. Lewis, III 4 Oct. 1968 129 p
(Contract NAS3-10497)
(NASA-CR-72457-VOL-2; PWA-3516-VOL-2) Avail: CFSTI CSCL 21E

Trends of variations in engine noise, performance, weight, and dimensions, as influenced by the primary engine thermodynamic cycle variables were studied. Representative noise, fuel consumption, thrust, and physical characteristic values were obtained for a set of combinations of bypass ratio, overall compressor and fan pressure ratios, and take-off and cruise turbine inlet temperatures. Noise values included peak noise (in PNdb's) at takeoff, approach, and cutback during climbout. Noise contours in the vicinity of the airport were computed at each of the aforementioned conditions for four representative cycle combinations. Noise, performance, weights, and dimensions were tabulated for 242 combinations of cycle variables for each of two different levels of takeoff thrust. Completion of such a comprehensive parametric study in only two months was made possible by the use of a statistical regression analysis technique. With this technique, approximately 40 cycle combinations were used as a sample set and trends for the remaining 200 combinations were obtained by statistical inference. Author

**N69-13481*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**QUIET ENGINE DEFINITION PROGRAM. VOLUME 3: TASK 2 Final Report**
John H. Lewis, III 4 Oct. 1968 95 p
(Contract NAS3-10497)
(NASA-CR-72457-VOL-3; PWA-3516-VOL-3) Avail: CFSTI CSCL 21E

The Task II results consist of mechanical design layouts and performance for four candidate engines. The three configurations initially selected for Task II studies are chiefly distinguished by their design bypass ratios. The design bypass ratios were 3.0, 5.0, and 8.0, and the associated engine designs have been designated QA, QB, and QC, respectively. Each engine had an overall design pressure ratio of 24.5, and the fan pressure ratios were selected to be best suited to each individual bypass ratio. Turbine inlet temperatures were chosen to be consistent with state of the art technology representative of the next generation of commercial transports. These design characteristics were chosen to take the best advantage of the low noise features of the cycles. Mechanical design layouts based on the completed analytical designs of components involved establishing the mechanical configuration in sufficient detail to define key dimensions, predict weights, and ascertain mechanical integrity. To this end, certain static structures were checked under critical loading conditions and rotor dynamics were checked for adequate critical-speed margins. Author

**N69-13482*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**QUIET ENGINE DEFINITION PROGRAM. VOLUME 5: QE-3 PERFORMANCE**
John H. Lewis, III 4 Oct. 1968 95 p
(Contract NAS3-10497)
(NASA-CR-72457-VOL-5; PWA-3516-VOL-5) Avail: CFSTI CSCL 21E

This report presents performance and installation data for an advanced study engine designated the QE-3. The engine is a high bypass ratio turbofan in the 22,000 lb. thrust class, and is the final selected study engine. Having evolved from earlier Tasks of the Quiet Engine Program, its cycle and configuration were especially selected to achieve low noise in a practical engine. While representing modern commercial engine technology, the QE-3 features a low tip speed, single stage fan intended to minimize fan generated noise, and high bypass ratio coupled with low turbine temperature intended to minimize jet exhaust noise. Author

**N69-13483*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**QUIET ENGINE DEFINITION PROGRAM. VOLUME 4: TASK 3 Final Report**
John H. Lewis, III 4 Oct. 1968 174 p refs
(Contract NAS3-10497)
(NASA-CR-72457-VOL-4; PWA-3516-VOL-4) Avail: CFSTI CSCL 21E

The overall Task III work effort to complete an engine design around the specified characteristics involved six main stages: (1) A fine-tuning study to define more precisely values for the design cycle variables which achieve an optimum arrangement within the constraints of maximum jet noise and maximum compressor spool pressure ratio; (2) A fan integration study to determine fan design characteristics best suited to low noise and compatibility with the overall engine design; (3) A preliminary aerodynamic design analysis for each component; (4) Conceptual mechanical design leading to

a preliminary engine structural arrangement; (5) Detailed aerodynamic design of the fan, and (6) Detailed aeroelastic analysis and mechanical design of the fan. Author

**N69-13526#** Hercules, Inc., Lawrence, Kans. Sunflower Ammunition Plant.
**EFFECT OF GRAIN-TO-MOTOR TUBE CLEARANCE ON THE PERFORMANCE OF THE 2.75-INCH FFAR Final Report, Feb.–Jul. 1968**
T. R. Trout 10 Oct. 1968 25 p
(Contract DA-11-173-AMC-42(A))
(AD-676574; SUN-143-120) Avail: CFSTI CSCL 19/7

Annular space was found to be critical at static test temperatures of +130 degrees F. or above. At these temperatures, excessive annular space caused high chamber pressures which resulted in catastrophic motor failures or severe shape and smoothness, pressure-time defects. Motors temperature conditioned to -65 degrees F. performed satisfactorily regardless of the amount of annular space. The test data showed that for consistently reliable motor performance with respect to annular space, the doweled diameter of a MK 43 Mod 1 propellant grain should not be less than 2.464 inches. If larger than normal motor tubes are to be used, the minimum doweled grain diameter should be increased accordingly. Author (TAB)

**N69-13533*#** Electro-Optical Systems, Inc., Pasadena, Calif.
**ANALYSIS OF ELECTRIC PROPULSION ELECTRICAL POWER CONDITIONING COMPONENT TECHNOLOGY. VOLUME 2 Final Report**
L. Klynn, P. Jalichandra, and R. Shattuck 1 Apr. 1968 100 p
(Contract NAS8-11257)
(NASA-CR-98148; EOS-5400-FINAL-V-2) Avail: CFSTI CSCL 21C

The 40–50 kW Mars mapper spacecraft general mission requirements are reviewed. This system consists of two solar array wings producing 50 kW with an output of 108 watts per square meter at a specific mass of 18 kg/kW. Sixteen cesium electron bombardment thrusters, at 2.5 kW each, are in a square matrix with one propellant tank supplying each four thruster group. The engines have an overall efficiency greater than 70 percent at a specific impulse of 3500 seconds with a power/thrust ratio of 24 kilowatts/newton. The engine system modes of operation are described for normal operation and alternates in case of failures. Three types of thrust programming are described; however, no conclusion can be reached until a more specific system is designed. The Mars mapper power conditioning and control system are delineated. A tradeoff between power conditioning and mass and efficiency results in a specific mass of less than 5 kg/kW for 18 kg/kW solar array. The technical report summary is concluded by a presentation of a sample of the problems involving the utilization of large solar arrays. Author

**N69-13614#** Curtiss-Wright Corp., Wood-Ridge, N. J.
**EXPLORATORY DEVELOPMENT PROGRAM ON YRC-180-2 AND RC2-60 ROTATING COMBUSTION ENGINES Final Report, 19 Jun. 1967–30 Jun. 1968**
H. Lamping Jul. 1968 122 p refs
(Contract N00019-67-C-0643)
(AD-676564; REPT-68-050167-F) Avail: CFSTI CSCL 21/7

The YRC-180-2 is an air-cooled, JP-5 fueled aircraft version of the rotating combustion engine. The RC2-60 is a fuel injected, spark ignited marine diesel fuel version of the rotating combustion engine. The RC1-90 liquid cooled combustion rig performs similar to the YRC-180-2 and can therefore be effectively utilized to evaluate combustion parameters for the air cooled engine. The engine did not develop the target fuel consumption using the 2.13 in. BTC injector location and standard 7.5:1 compression ratio rotor, although the potential for developing rated power has been demonstrated. Performance of the 90 cubic inch chamber is not up to the 60 cubic inch chamber at this stage of development, probably as a result of less optimum axial fuel distribution. The cooling improvements demonstrated, when combined with a blower meeting design requirements and improvements anticipated from combustion improvements, will permit cooling the YRC-180-2 engine to maximum power rating. The RC1-90 demonstrated power output above that required to meet the YRC-180-2 rating; 163.5 HP demonstrated on 1-90 is equivalent to 324 HP for the YRC-180-2 versus the 310 HP rating. Additional development work is required on the YRC-180-2 to achieve performance targets, cooling capability and durability. Author (TAB)

**N69-13875#** Imperial Metal Industries, Ltd., Kidderminster (England). Summerfield Research Station.
**APOGEE MOTORS FOR CETS COMMUNICATION SATELLITES Final Report**
May 1968 95 p refs Prepared for ELDO
Avail: CFSTI

Designs are described of solid propellant rocket motors suitable for use as apogee motors in the launching of geostationary communication satellites for CETS. An outline is given of the necessary development and qualification programs and costs. Two basic solutions are proposed, one with a high strength steel case, and the other with a glass reinforced plastic case. The propellant, which for both types of motor is bonded to the motor case by a layer of insulation, is composite-modified cast-double-base and delivers a specific impulse in vacuo of 2893 Ns/Kg. ESRO

# 29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

**N69-12613#** Library of Congress, Washington, D. C. Aerospace Technology Div.
**KOSMOS-166 MEASUREMENTS OF SOLAR X-RAY RADIATION**
Boris Doncov *In its* Foreign Sci. Bull., Vol. 4, No. 11, Nov. 1968 p 1–7 refs (See N69-12612 03-34)
Avail: CFSTI

Preliminary results of the Kosmos 166 flight (June–September 1967) are presented on the location and dynamics of generation of x-radiation in the solar corona and the variation of the spectral composition of this radiation during quiet Sun periods and solar flares. The equipment used is also described. Author

**N69-12960*#** Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
**THE RADIAL GRADIENT OF INTERPLANETARY RADIATION MEASURED BY MARINERS 4 AND 5**
S. M. Krimigis and D. Venkatesan (Calgary Univ., Alberta) 1968 55 p refs
(Grants NaG-233-62; NGL-16-001-002)
(NASA-CR-97871; Rept.-68-61) Avail: CFSTI CSCL 20H

The detector package on the Mariner 4 spacecraft, which was launched on a Mars-bound trajectory on 28 November 1964, includes a shielded GM tube (detector C) whose threshold is

about 50 to 55 MeV/nucleon for proton and alpha particles. By comparing the counting rate of detector C to that of a similar earth-orbiting GM tube on the IMP-OGO series of spacecrafts we find the following: (a) As the difference in heliocentric longitude between the two spacecraft increases, there appear differences in the time and/or space development of a Forbush decrease. (b) The gradient of particles in the interplanetary medium with energies above the detector energy threshold is directed *towards* the sun. (c) Additional data from the Venus-bound Mariner 5 spacecraft and the Mariner 4 and IMP-OGO spacecrafts show that the gradient ranged from −24 to −29%/A.U. (d) It is shown that the interplanetary flux of particles of E > 50 MeV/nucleon must in part be of solar origin. (e) It is argued that the gradient of galactic cosmic radiation of E ≈ 50 MeV/nucleon cannot be measured even at the time of solar minimum. Author

**N69-13271*#** Maryland Univ., College Park. Physics and Astronomy Dept.

**SOURCE REQUIREMENTS FOR THE FLUCTUATION ORIGIN OF COSMIC RADIATION**

J. R. Wayland Sep. 1968 37 p

(Grant NGL-21-002-033)

(NASA-CR-98515; TR-889) Avail: CFSTI CSCL 20H

Conditions placed upon a source of cosmic ray particles within a model of the origin of cosmic rays in which fluctuations in the momentum changing process are important were investigated. This is done by considering the relationship between $<\Delta p>$ and $<\Delta p^2>$, where $\Delta p$ is the momentum change in a collision. With the assumption that the energy due to turbulent motion, cosmic rays, and the magnetic field are linearly related, we find an expression for the number density of cosmic ray particles ejected from a changing volume in terms of their average kinetic energy. We consider this in terms of the fluctuation model to obtain other source requirements. It is found that over a large range of astrophysical phenomena the dominance of fluctuation can be important to the origin of cosmic radiation. Author

**N69-13478#** Uppsala Univ. (Sweden). Cosmic Ray Group.

**COSMIC RAY INTENSITY VARIATIONS DURING 1967**

Arne E. Sandstrom and Birgitta Kangedal 1 Jul. 1968 20 p refs

(Contract AF 61(052)-868)

(AD-676681; SN-5) Avail: CFSTI CSCL 4/1

The variations with time of the diurnal phase at Uppsala and Kiruna has been studied for the years 1956–1967. A 22-year period is indicated, but probably some kind of fine structure is also present. It has turned out, also, that the south pointing and north pointing meson instruments at Kiruna display a phase difference which varies linearly with the relative sunspot number. The correlation coefficient is 0.97. Author (TAB)

**N69-13519#** Atomic Energy of Canada, Ltd., Chalk River (Ontario).

**COSMIC RAY NM-64 NEUTRON MONITOR DATA-X AND MONTHLY GRAPHS, MAY–AUGUST 1968**

J. F. Steljes Sep. 1968 79 p refs

(AECL-3161) Avail: Atomic Energy of Canada, Ltd., Chalk River: $2.00

Uncorrected and barometer corrected results from the cosmic ray stations in Canada using are given in tabular form. Normalized graphs are given for the same period. Author

**N69-13561#** Aerospace Corp., El Segundo, Calif.

**ENHANCEMENT OF THE SOLAR X-RAY SPECTRUM BELOW 25 A DURING SOLAR FLARES**

Arthur B. C. Walker Jun. 1968 27 p refs

(Contract F04695-67-C-0158)

(AD-676264; TR-0158(9260-02)-4; SAMSO-TR-68-367) Avail: CFSTI CSCL 3/2

The scanning Bragg crystal spectrometer flown aboard the satellite 1966-111B observed the solar x-ray spectrum between 8 and 25 A shortly after the occurrence of a class 3 flare on 13 February 1967. Comparison of this spectrum with x-ray spectra obtained during periods of moderate solar activity shows that while the low ionization potential lines of O VII and N VII increase only 50% in intensity, the higher ionization potential lines of Fe XVII, Ne X, Mg XI, Fe XVIII, and Ni XIX increase in intensity from three to ten times. The lines of Mg XII and Na XI, which were indistinguishable from the continuum before, become prominent in the flare spectra. A number of new lines were observed, which are of the proper wavelength to be identified with the transitions of Fe XIX through Fe XXIV recently observed on the sun by OSO III and since observed in laboratory spark spectra. Abeolute intensities of emission lines and of the x-ray continuum for the 13 February flare spectra and for a more typical spectrum are reported. Author (TAB)

**N69-13714#** Denver Univ., Colo. Dept. of Physics.

**INFRARED SOLAR SPECTRUM IN THE 1.1 MICROMETER REGION OBSERVED FROM A BALLOON BORNE SPECTROMETER**

Aharon Goldman, David Murcray, Frank Murcray, and Walter Williams Aug. 1968 19 p refs

(Contract F19628-68-C-0233; ARPA Order 363)

(AD-676279; AFCRL-68-0436; SR-2) Avail: CFSTI CSCL 3/2

Records are presented of the infrared solar spectrum in the 1.1 micrometer region, observed from altitudes up to 30 km, with a resolution of 0.50A. The spectra show many new solar absorption lines which appear only at high altitudes where the telluric absorptions are eliminated. Author (TAB)

**N69-13730#** Joint Publications Research Service, Washington, D. C.

**UPPER ATMOSPHERE AND SPACE RESEARCH**

*In its* Soviet-Bloc Res. Geophys., Astronomy, and Space 29 Nov. 1968 p 18–55 (See N69-13726 03-34)

Avail: CFSTI

Detailed news items are reported on the launching and flight of Soyuz 3, the ground support system, and the rendezvous techniques. Other items include the launching of Cosmos 260, 251, and 252, the Orbita communications satellite station network, Cuban satellite tracking stations, capabilities of earth resources satellites, and proposed method for detecting water on the moon. Books are reviewed on the dynamics of the earth's radiation belts, bourgeois space law theories, ballistic missile gyroscopes, spacecraft automatic guidance and control, and U.S. military space aims. Selected scientific articles in space research are abstracted. Characteristics of the F1.5 layer, corpuscular heating of the polar ionosphere, radioastronomical study of ionospheric inhomogeneities, and cosmic radiation absorption bursts in the ionosphere are included. Studies were also made of cosmic rays and the dynamics of solar wind, composition of the nighttime ionosphere, predawn effect in $f_0F2$ variations, upper atmosphere research and geomagnetism. B.P.

# 30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

**N69-12601** Stanford Univ., Calif.
**THE EFFECT OF 3-DIMENSIONAL NONLINEAR RESONANCES ON THE MOTION OF A PARTICLE NEAR THE EARTH-MOON EQUILATERAL LIBERATION POINTS**
Hans Berthold Schechter (Ph.D. Thesis) 1967 121 p
Avail: Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-17496

This dissertation presents the results of an analytic study of the 3-dimensional stability of motion of a particle near $L_4$ in a nonlinear Earth-Moon force field, upon which is superimposed a linear solar gravitational field distribution. In particular, the long period features of the particle's motion are studied, which stem from the excitation at or close to the particle's natural frequencies, and are introduced by the presence of resonance terms in the internal (Earth and Moon) and external (solar) force fields. The results show that in the presence of the internal nonlinearities the stability of motion predicted by the linear theory is valid for only a very restricted region of initial displacement and velocity disturbances. Disturbances outside this region would lead to divergence of the solution. Dissert. Abstr.

**N69-12637*#** Arizona Univ., Tucson.
**COMMUNICATIONS OF THE LUNAR AND PLANETARY LABORATORY, COMMUNICATIONS NOS. 93–99, VOLUME 6, PART 3**
G. P. Kuiper, ed. 1967 61 p refs
(Grant NGL-03-002-002)
(NASA-CR-97962) Avail: CFSTI CSCL 03B

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2. SOLAR COMPARISON SPECTRA, 1.0–2.5μ, FROM ALTITUDES 1.5–12.5 km G. P. Kuiper and D. L. Steinmetz p 171–176 (See N69-12639 03-30)

3. HIGH ALTITUDE SPECTRA FROM NASA CV 990 JET. 1: VENUS, 1–2.5 MICRONS, RESOLUTION 20/cm G. P. Kuiper and F. F. Forbes p 177–189 refs (See N69-12640 03-30)

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5. SULPHUR COMPOUNDS IN THE ATMOSPHERE OF VENUS. 1: AN UPPER LIMIT FOR THE ABUNDANCE OF $SO_2$ D. P. Cruikshank and G. P. Kuiper p 195–197 refs (See N69-12642 03-30)

6. SULPHUR COMPOUNDS IN THE ATMOSPHERE OF VENUS. 11: UPPER LIMITS FOR THE ABUNDANCE OF COS AND $H_2S$ D. P. Cruikshank p 199–200 refs (See N69-12642 03-30)

7. THE INFRARED SPECTRUM OF CARBON SUBOXIDE. PART 1: REGION 1–2.5 MICRONS. PART 2: REGION 2–15 MICRONS. PART 3: CLASSIFICATION OF $C_3O_2$ VIBRATIONAL BANDS G. P. Kuiper, G. T. Sill, D. P. Cruikshank, and U. Fink p 201–207 refs (See N69-12644 03-30)

**N69-12638*#** Arizona Univ., Tucson.
**A PROGRAM OF ASTRONOMICAL INFRARED SPECTROSCOPY FROM AIRCRAFT**
G. P. Kuiper, F. F. Forbes, and H. L. Johnson *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 93–99, Vol. 6, Pt. 3 1967 p 155–170 refs *Its* Commun. No. 93 (See N69-12637 03-30)
Avail: CFSTI CSCL 03B

A program of astronomical infrared spectroscopy from aircraft is developed based on the facilities offered by the NASA CV 990 jet, with its 65° window ports and its gyrostatically controlled heliostats. A 12-in. horizontal telescope on shock mounts was added, equipped with standard astronomical attachments for spectral observation of the PbS region of the infrared. The vertical distribution of water vapor in the atmosphere in the middle latitudes which determines the relative efficiency of flight operations from different heights are tabulated. Data from a description is given of the NASA-developed procedures for observation of planets and stars of different declinations. The eight operational flights that took place in the spring of 1967 are also tabulated. The efficiency of this approach was much increased when it was shown that a medium-resolution Block interferometer could be used in spite of aircraft vibrations or expected scintillation effects. Author

**N69-12639*#** Arizona Univ., Tucson.
**SOLAR COMPARISON SPECTRA, 1.0–2.5 μ FROM ALTITUDES 1.5–12.5 km**
G. P. Kuiper and D. L. Steinmetz *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 93–99, Vol. 6, Pt. 3 1967 p 171–176 *Its* Commun. No. 94 (See N69-12637 03-30)
Avail: CFSTI CSCL 03B

Infrared spectra of planets and stars taken from aircraft require solar calibrations showing the telluric spectrum in its dependence on the altitude of observation. In addition, since numerous solar lines are present as well, the blending of these with the telluric spectrum must be known in the analysis of the planetary spectra. The latter contain the same bands, in turn superposed on the absorption spectrum of the planetary atmosphere. The solar spectra obtained on June 23, 1967, with the NASA 990 Jet and the Block interferometer, the same equipment used in the observation of Venus and Mars, are given. The records were made from various altitudes; the increment is 5000 ft (1.5 km) up to 35,000 ft, with 1000 ft (0.3 km) increments near the ceiling altitude of 41,000 ft (12.5 km). Attention is called to the remarkable internal agreement of the records testifying to the excellent performance of the Block interferometer. Author

**N69-12640*#** Arizona Univ., Tucson.
**HIGH ALTITUDE SPECTRA FROM NASA CV 990 JET. 1: VENUS, 1–2.5 MICRONS, Resolution 20/CM**
G. P. Kuiper and F. F. Forbes *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 93–99, Vol. 6, Pt. 3 1967 p 177–189 refs *Its* Commun. No. 95 (See N69-12637 03-30)
(Grant NsG-161-16)
Avail: CFSTI CSCL 03B

Results from two high-altitude flights in the spring of 1967 show the Venus atmosphere to be essentially devoid of water vapor and ice crystals. One or two new absorption bands are found, further study of which is deferred until the acquisition of spectra with higher resolution scheduled for late November 1967. The importance is stressed of powerful IR spectral studies from the lower stratosphere. Author

**N69-12641*#** Arizona Univ., Tucson.
**CALIBRATION OF WEAK 1.4 AND 1.9 μ WATER-VAPOR ABSORPTIONS**
G. P. Kuiper and D. P. Cruikshank *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 93–99, Vol. 6, Pt. 3 1967 p 191–194 *Its* Commun. No. 96 (See N69-12637 03-30)
(Grant NsG-161-61)
Avail: CFSTI CSCL 03B

Laboratory measurements of the intensity of the water-vapor bands in support of airborne observations of the planets Venus and Mars are summarized. Author

N69-12642*# Arizona Univ., Tucson.
**SULPHUR COMPOUNDS IN THE ATMOSPHERE OF VENUS. 1: AN UPPER LIMIT FOR THE ABUNDANCE OF SULPHUR DIOXIDE**
D. P. Cruikshank and G. P. Kuiper *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 93–99, Vol. 6, Pt. 3 1967 p 195–197 refs *Its* Commun. No. 97 (See N69-12637 03-30)
(Grant NsG-161-61)
Avail: CFSTI CSCL 03B

From the $SO_2$ electronic bands near 3000 Å an upper limit of 0.05 mm-atm was derived for the $SO_2$ content of the Venus atmosphere. Author

N69-12643*# Arizona Univ., Tucson.
**SULPHUR COMPOUNDS IN THE ATMOSPHERE OF VENUS. 2: UPPER LIMITS FOR THE ABUNDANCE OF CARBONYL SULFIDE AND HYDROGEN SULFIDE**
D. P. Cruikshank *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 93–99, Vol. 6, Pt. 3 1967 p 199–200 refs *Its* Commun. No. 98 (See N69-12637 03-30)
(Grant NsG-161-61)
Avail: CFSTI CSCL 03B

Laboratory spectra of small amounts of carbonyl sulfide and hydrogen sulfide are discussed relative to their abundance in the Venus atmosphere. The upper limits to the mixing ratios relative to a two-way transmission in the Venus atmosphere. The 4 km-atm of $CO_2$, are: $COS < 10^{-6}$ and $H_2S < 2 \times 10^{-4}$. Author

N69-12644*# Arizona Univ., Tucson.
**THE INFRARED SPECTRUM OF CARBON SUBOXIDE. PART 1: REGION 1-2.5 MICRONS. PART 2: REGION 2-15 MICRONS. PART 3: CLASSIFICATION OF CARBON SUBOXIDE VIBRATIONAL BANDS**
G. P. Kuiper, G. T. Sill, D. P. Cruikshank, and Uwe Fink *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 93–99, Vol. 6, Pt. 3 1967 p 201–207 refs *Its* Commun. No. 99 (See N69-12637 03-30)
(Grant NsG-161-61)
Avail: CFSTI CSCL 03B

Laboratory tests of the spectrum of $C_3O_2$ in the region of 1-15 microns are presented in order to establish the most suitable tests for the presence of this gas on Venus and Mars. An ultraviolet test for $C_3O_2$ in the Venus atmosphere and the classification of $C_3O_2$ vibrational bands are also mentioned. Author

N69-12667 Michigan Univ., Ann Arbor.
**THE STRUCTURE OF NGC 6822**
Nancy Elizabeth Weber Boggess (Ph.D. Thesis) 1967 109 p
Avail: Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-17729

This study is intended to describe the structure of the NGC 6822 galaxy and, in particular, the distribution of its Population I elements. The most obvious Population I objects in NGC 6822 are the five large nebulosities. The nebular contours were calibrated through a photometric comparison with the diffuse nebula M 16, and total luminosities, densities, masses, and models of their large-scale structures were derived. These nebulae are probably ionization bounded, and their luminosities require that they be excited by at least one O5 star. It appears that NGC 6822 and the Magellanic Clouds represent a class of galaxies closely related to barred spirals and that many of the so-called irregular galaxies may fall in this category. The exact nature of their relation to SB types is not clear, but their structure may be a consequence of the low mass of these pseudo-barred spirals. Dissert. Abstr.

N69-12743*# Arizona Univ., Tucson.
**COMMUNICATIONS OF THE LUNAR AND PLANETARY LABORATORY, COMMUNICATIONS NOS. 112–113 VOLUME 7, PART 2**
G. P. Kuiper, ed. 1968 52 p refs
(Grant NGL-03-002-002)
(NASA-CR-97960) Avail: CFSTI CSCL 03B

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N69-12744*# Arizona Univ., Tucson.
**UBVRIJKL LIGHT CURVES OF CLASSICAL CEPHEIDS**
W. Z. Wisniewski and H. L. Johnson *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 112–113, Vol. 7, Pt. 2 1968 p 57–82 refs *Its* Commun. No. 112 Supported by ONR (See N69-12743 03-30)
Avail: CFSTI CSCL 03B

Tables and graphs are presented of the multicolor photoelectric observations on the UBVRIJKL system for classical Cepheid variable stars. The data are sufficient to define light curves as wavelengths ranging from the ultraviolet to the infrared. The light curves exhibit the well-known shift of phase with wavelength. Several stars (SU Cas, DT Cyg and SZ Tau) seem not to show much phase shift. These same three stars are also almost constant in light output at 2.2$\mu$ and 3.4$\mu$. Another group of stars ($\eta$ Aql, U Aql, W Gem, S Sge and U Sge) have secondary bumps on the visual light curves. It is suggested that this effect may be related to the phase shifts exhibited by stars with asymmetrical light curves. Author

N69-12745*# Arizona Univ., Tucson.
**STELLAR SPECTROSCOPY, 1.2 $\mu$ TO 2.6 $\mu$**
H. L. Johnson, I. Coleman, R. I. Mitchell, and D. L. Steinmetz *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 112–113, Vol. 7, Pt. 2 1968 p 83–103 refs *Its* Commun. No. 113 Supported in part by NSF (See N69-12743 03-30)
Avail: CFSTI CSCL 03B

Infrared spectroscopic observations were made of 21 stars, using a rapid-scanning Michelson interferometer. The range of wavelength is from 1.2 $\mu$ (8200 $cm^{-1}$) to 2.6 $\mu$ (3900 $cm^{-1}$), and the resolution is 8 $cm^{-1}$. All spectra were corrected for atmospheric extinction, mostly by the method of equal-altitude photometric transfers from standard objects. The atmospheric transmission corrections are based upon a lunar spectrum obtained from the NASA Convair 990 jet aircraft, at an altitude of 41,500 feet. The corrected ground-obtained spectrum of a $\alpha$ Ori was checked by an aircraft spectrum of the same star, showing that the extinction corrections are valid. Only four stars, all Mira variable stars, showed significant amounts of steam absorption in their spectra. There exists a correlation of this absorption with long-wavelength (9–14 $\mu$) infrared excess for giant stars, but not for supergiants. Author

N69-12799*# Arizona Univ., Tucson.
**COMMUNICATIONS OF THE LUNAR AND PLANETARY LABORATORY, COMMUNICATIONS NOS. 114–122, VOLUME 7, PART 3**
G. P. Kuiper, ed. 1968 82 p refs
(Grant NGL-03-002-002)
(NASA-CR-97959) Avail: CFSTI CSCL 03

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1. THE INFRARED POLARIZATION OF THE MOON F. F. Forbes and P. A. Welch p 105–110 refs (See N69-12800 03-30)

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5. LUNAR CRATER COUNTS. 5: LATITUDE INDEPENDENCE AND SOURCES OF IMPACTING BODIES W. K. Hartmann p 139–144 refs (See N69-12804 03-30)

6. LUNAR CRATER COUNTS. 6: THE YOUNG CRATERS TYCHO, ARISTARCHUS, AND COPERNICUS W. K. Hartmann p 145–156 refs (See N69-12805 03-30)

7. STATISTICS OF CENTRAL PEAKS IN LUNAR CRATERS C. A. Wood p 157–160 refs (See N69-12806 03-30)

8. LUNAR VOLCANIC ERUPTIONS NEAR ARISTARCHUS W. K. Hartmann and D. H. Harris p 161–167 refs (See N69-12807 03-30)

9. MINOR PLANETS. 1: THE ROTATION OF VESTA T. Gehrels p 169–178 refs (See N69-12808 03-30)

**N69-12800*#** Arizona Univ., Tucson.
**THE INFRARED POLARIZATION OF THE MOON**
F. F. Forbes and P. A. Welch *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 114–122, Vol. 7, Pt. 3 1968 p 105–110 refs *Its* Commun. No. 114 (See N69-12799 03-30)
(Contract NSR-03-002-048; Grant NSF GP-4999)
Avail: CFSTI CSCL 03B

Infrared polarization measurements of the lunar surface have been obtained at 1.25 and 2.2 $\mu$ for the lunar phase −80°.9. The infrared polarization of the entire Moon was found to be 3.24 and 2.90 percent at 1.25 and 2.2 $\mu$, respectively. The new infrared polarization results were compared to the visible and ultraviolet polarization obtained by Gehrels, *et al.* (1964), Coyne (1967), and Lyot (1929). As with other wavelengths, the infrared polarization is greater in the maria than in the highlands. In addition to the polarization scans and the determination of the polarization of the entire Moon at −80.9° phase, the geometric albedo was computed from photometric scans of the Moon at 3.48° and −80.9° phases and found to be 0.211, 0.259, and 0.321 at 1.25, 1.62 and 2.24 $\mu$, respectively. The ground-based geometric albedo values agree well with those obtained from Project Lamplighter of May 1968 on the Gemini 7 Mission. Author

**N69-12801*#** Arizona Univ., Tucson.
**EXPLOSION CRATERS ON THE EARTH AND MOON**
G. Fielder and J. E. Guest (London Univ. Obs.) *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 114–122, Vol. 7 Pt. 3 1968 p 111–123 refs *Its* Commun. No. 115 Supported by N.E.R.C., London (See N69-12799 03-30)
Avail: CFSTI CSCL 03A

A comparison of lunar craters with a particular set of similar-sized explosion craters on Earth leads to the inference that explosion craters on the Moon can be picked out with the aid of the following criteria: (a) relative altitude of rim crest and shape of outer rim profile, (b) slumping of inner rim materials, (c) nature and distribution of ejecta. Author

**N69-12802*#** Arizona Univ., Tucson.
**LUNAR CRATER COUNTS. 3: POST MARE AND "ARCHIMEDIAN" VARIATIONS**
William K. Hartmann *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 114–122, Vol. 7, Pt. 3 1968 p 125–129 refs *Its* Commun. No. 116 Supported in part by NSF (See N69-12799 03-30)
(Grant NsG-161-61)
Avail: CFSTI CSCL 03A

Presented are data on inter-mare crater density variations which support statements. The extreme crater densities (Mare Serenitatis and Mare Tranquilitatis) vary by a factor of approximately 2.5. Table 2 presents quantitative and qualitative estimates of the post-basin crater densities, as well as post-mare crater densities for various basin systems, arranged in order of basin age. The "Archimedian" craters considerably outnumber the post-mare craters. "Archimedian" time periods were finite and variable from basin to basin, thus excluding impact-induced melting as a source of mare material. These data demonstrate a working approach for future crater count programs. Author

**N69-12803*#** Arizona Univ., Tucson.
**LUNAR CRATER COUNTS. 4: MARE ORIENTALE AND ITS BASIN SYSTEM**
W. K. Hartmann and F. G. Yale *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 114–122, Vol. 7, Pt. 3 1968 p 131–137 refs *Its* Commun. No. 117 Supported in part by NSF (See N69-12799 03-30)
(Grant NsG-161-61)
Avail: CFSTI CSCL 03A

Parts I and II present crater count observations of the mare surface and the ejecta blanket of the Orientale basin. Mare Orientale has the crater density of average maria, 1.0, and the ejecta blanket has an unusually low crater density for an upland surface, 2.4. This is the lowest known post-basin crater density, testifying to the youth of the system. Supplemental observations based on Orbiter photography are presented in part III. Part IV discusses the physics of the hypothetical, nuée ardente-like cloud which swept out from the impact site, depositing the striated, highly-structured blanket shown in the Orbiter photographs. Part V summarizes the history of the Orientale basin system. The extraordinary clarity of the radial and concentric lineaments is attributed to the youth of the system and the probable coincidence in time of the impact and the beginning of the mare-forming period, with the shocked "crust" collapsing into the plastic substratum along impact-produced fractures. Author

**N69-12804*#** Arizona Univ., Tucson.
**LUNAR CRATER COUNTS. 5: LATITUDE INDEPENDENCE AND SOURCES OF IMPACTING BODIES**
William K. Hartmann *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 114–122, Vol. 7, Pt. 3 1968 p 139–144 refs *Its* Commun. No. 118 Supported in part by NSF (See N69-12799 03-30)
(Grant NsG-161-61)
Avail: CFSTI CSCL 03A

The larger pre-mare lunar craters are concentrated toward the lunar poles by a factor two over their equatorial densities. Post-mare craters are almost uniformly distributed, with only a marginal trace of the polar concentration. It is concluded that the moon's obliquity has not changed since the pre-mare craters formed; that impacting bodies during the early intense lunar bombardment were concentrated toward high latitudes by an uncertain mechanism, possibly related to the gravitational field of the nearby earth; that the early bombardment involved a different population of bodies than the post-mare and current influx; and that the declining early bombardment lasted into early post-mare time. The early projectiles may have been residual planetesimals in solar orbit or members of a circum-terrestrial swarm. Celestial mechanical studies of such bodies are highly desirable. Author

**N69-12805*#** Arizona Univ., Tucson.
**LUNAR CRATER COUNTS. 6: THE YOUNG CRATERS TYCHO, ARISTARCHUS, AND COPERNICUS**
William K. Hartmann *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 114–122, Vol. 7, Pt. 3 1968 p 145–156 refs *Its* Commun. No. 119 Supported in part by NSF (See N69-12799 03-30)
(Grant NsG-161-61)
Avail: CFSTI CSCL 03A

The crater densities inside the craters Tycho, Aristarchus, and Copernicus are found to be respectively 0.1, 0.3, and 0.5 times the mean crater densities on maria. Ages of $2 \times 10^8$, $1 \times 10^9$, and $2 \times 10^9$ yr are inferred. The interior of Copernicus exhibits a number of recognizable volcanic structures. Rays accompanying these craters are probably finely pulverized ejecta and are destroyed on a time scale of about $3 \times 10^9$ years by stirring and mixing of the upper layers of the lunar surface to a depth on the order of a centimeter. Primary impact craters exhibit approximately a −2 power law diameter distribution to diameters as low as 250m, indicating that most hectometer-size craters (which together define a much steeper power law) are not primary impact craters. Author

**N69-12806*#** Arizona Univ., Tucson.
**STATISTICS OF CENTRAL PEAKS IN LUNAR CRATERS**
Charles A. Wood *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 114–122, Vol. 7, Pt. 3 1968 p 157–160 refs *Its* Commun. No. 120 (See N69-12799 03-30)
(Grant NsG-161-61)
Avail: CFSTI CSCL 03A

Statistics of central peaks are drawn from the large catalog, "The System of Lunar Craters." Only about 3% of all cataloged craters have peaks; this value is much smaller than has been previously reported. However, the percentage of craters with observed central peaks increases markedly with size and approaches 100% for undamaged craters of diameter 70 km and larger. Young (undamaged) craters have peaks more frequently than older craters. Author

**N69-12807*#** Arizona Univ., Tucson.
**LUNAR VOCANIC ERUPTIONS NEAR ARISTARCHUS**
W. K. Hartmann and D. H. Harris *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 114–122, Vol. 7, Pt. 3 1968 p 161–167 refs *Its* Commun. No. 121 (See N69-12799 03-30)
(Grant NGR-03-002-091)
Avail: CFSTI CSCL 03A

The characteristics of five glowing spots observed near Aristarchus are shown to be compatible with moderate-sized eruptions of molten material. Orbiter photographs of the area show that at least three of the sites occur near well-defined lava flows, and either open rifts or cone-like structures. None of the sites contains volcanic structures so anomalous or fresh-looking as to be identified as products of a 1963 eruption. Nevertheless, it appears probable that the 1963 events were volcanic eruptions, probably including "fire fountains." Author

**N69-12808*#** Arizona Univ., Tucson.
**MINOR PLANETS. 1: THE ROTATION OF VESTA**
Thomas Gehrels *In its* Commun. of the Lunar and Planetary Lab., Commun. Nos. 114–122, Vol. 7, Pt. 3 1968 p 169–178 refs Repr. from Ast. J., v. 72, no. 8, Oct. 1967 *Its* Commun. No. 122 Supported in part by ONR (See N69-12799 03-30)
Avail: CFSTI CSCL 03A

A set of 13 light curves for 4 Vesta was obtained between November 1958 and May 1959. The set is compared with light curves observed in 1950 (by H. L. Johnson), in 1952 (D. L. Harris), 1954 (L. Binnendijk), and 1967 (this paper). The speed as well as the sense of rotation are derived from the effect of aspect change on the apparent rotational period ("photometric astrometry"). The rotation is direct, the true period is $5^h20^m\ 31^s.665$ ($\pm 0^s.003$ p.e.), and the ecliptic longitude and latitude of the north pole are $128^\circ$ ($\pm 5^\circ$) and $+65^\circ$ ($\pm 4^\circ$). Vesta differs from the other asteriods in that its light curve has only one maximum and one minimum, indicating a nearly spherical shape for Vesta with a darker, and slightly bluer, region on one side. The brightness-phase function shows a nonlinear increase near opposition ("opposition effect"). The colors B–V and U–B increase with the orbital phase angle (reddening with phase). Author

**N69-12824#** Joint Publications Research Service, Washington, D. C.
**ASTRONOMY**
*In its* Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 192 20 Nov. 1968 p 1–6 refs (See N69-12823 03-34)
Avail: SOD/CFSTI

News items and abstracts of scientific articles are presented concerning the following: (1) Soviet observations and studies of the chromosphere, pulsars, discovery of new giant stars, interstellar dust, and anisotropy of cosmic radiation; (2) new telescope construction at the Byurakan Astrophysical Observatory; (3) radioastronomical studies of solar eclipses; (4) adjustment, setting, and description of electro-optical modulators; (5) an automatic scanning device for a solar telescope; and (6) lifetime of magnetohydrodynamic waves in the chromosphere. K.W.

**N69-12826#** Joint Publications Research Service, Washington, D. C.
**OCEANOGRAPHY**
*In its* Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 192 20 Nov. 1968 p 58–79 refs (See N69-12823 03-34)
Avail: SOD/CFSTI

News items and abstracts of scientific articles are presented on the following: (1) equipment and operation of the research ships "Akademik Kurchatov", "Akademik Vernadskiy", and "Iney"; (2) instruments and equipment, including an automatic shipboard gravimeter, a gyroscopically stabilized gravimeter, quality factor of a vibrating-string system, an automatic seismograph marker, a vertical gravitational gradient gage, and operation of a ferrosonde pickup under resonance conditions; (3) methods and techniques for computing and measuring radiant energy, underwater exploitation of minerals, ocean current calculations, and oceanographic planning; (4) studies of effects of drift currents and turbulence on wind stress, pyroclastic materials in the Pacific, organic carbon in the Norwegian Sea and the Atlantic and geochemistry of rare alkalies in oceans; and (5) signing of declaration on Continental Shelf by U.S.S.R., Poland, and East Germany. K.W.

**N69-12845** Michigan Univ., Ann Arbor.
**MINIMUM FUEL TRAJECTORIES FOR THE SYNERGETIC PLANE CHANGE MANEUVER**
M. Michael Bonner (Ph.D. Thesis) 1967 176 p
Avail: Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 67-17730

The synergetic plane change maneuver is a method of changing the orbital plane of an earth satellite utilizing both aerodynamic forces and propulsive forces. A satellite vehicle is assumed to be designed so as to be able to generate aerodynamic forces with lift-to-drag ratios greater than one together with rocket propulsion forces in an arbitrary direction. This study discusses

optimal (in the sense of minimum fuel or ideal $\Delta V$) trajectories for synergetic plane changes in the presence of state and control variable constraints representing instantaneous stagnation point temperature and thrust acceleration. The trajectories considered all begin and terminate in a circular orbit at an altitude of 700 nautical miles. In general, the optimum synergetic maneuver is better than the rocket-only maneuver for inclination changes greater than 20° for the range of vehicle parameters investigated, and for 60° plane changes the synergetic maneuver can be better than the rocket-only maneuver by a factor of 2.7 in $\Delta V$. When one considers the effect of changes in vehicle wing-loading due to fuel burned, it appears that up to three 60° synergetic maneuvers can be made with the fuel required to make one rocket-only maneuver. Dissert. Abstr.

**N69-12888** Wisconsin Univ., Madison.
**MODELS FOR CARBON-OXYGEN STARS OF ONE SOLAR MASS IN THE LATE STAGES OF EVOLUTION**
Laura Patricia Bautz (Ph.D. Thesis) 1967 196 p
Avail: Univ. Microfilms: HC $9.00/Microfilm $3.00 Order No. 67-12409

Two evolutionary sequences of models for gravitationally contracting, partially degenerate stars of one solar mass have been constructed. Sequence I consisted of models for a star having a carbon-oxygen core and a helium envelope which was joined to the core at $\log(M_r/M) = -10^{-4}$. Energy losses due to photo- and plasma neutrino emission were included. Neutrino emission acted as a thermostat which prevented the star from reaching temperatures sufficient to burn carbon. Contraction from $.13R_\odot$ to $.01R_\odot$ took place in $1.5 \times 10^5$ years. The track in the color magnitude diagram is similar in shape and in average luminosity to the track proposed by Harmon and Seaton (1964) for the evolution of the central stars of planetary nebulae. Radii of the models were consistently smaller than the observations indicate by about a factor of eight, however, and the total range in luminosity was a factor of two less than observed. Dissert. Abstr.

**N69-13062*** Massachusetts Inst. of Tech., Cambridge Research Lab. of Electronics.
**RADIO ASTRONOMY**
*In its* Res. Lab. of Electron. 15 Oct. 1967 p 5–15 refs (See N69-13060 03-34)
(Contract NSR-22-009-120; Grant NsG-419; Contracts DA-28-043-AMC-02536(E); N00014-67-A-0204-0009; Grant NSF GP-7046)
Avail: CFSTI CSCL 03A

Cosmic background measurements at 9.24 mm are presented. Other measurements using very-long-baseline interferometry with independent time standards are presented. NSA

**N69-13141** Virginia Univ., Charlottsville.
**BRIGHTNESS DISTRIBUTIONS OF RADIO SOURCES AT 2695 MHz**
Francis Ness Bash (Ph.D. Thesis) 1967 231 p
Avail: Univ. Microfilms: HC $10.60/Microfilm $3.00 Order No. 67-17586

Measurements are reported of the fringe amplitude for 234 radio sources using the N.R.A.O. interferometer operating at 2695 MHz. The sources were observed at five antenna separations, 10789λ, 13484λ, 16182λ, 18879λ, and 24274λ, as they crossed the interferometer equator. The source list includes about 50 identified quasi-stellar sources and about 70 identified radio galaxies. Models of the strip brightness distribution have been fitted to the observed fringe visibilities for about 190 of the sources. The most complex model used had two components, since with five observations, one is restricted to models with fewer than five degrees of freedom. Dissert. Abstr.

**N69-13200*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**MAGNETIC FIELD EXPERIMENT PIONEERS 6, 7 AND 8**
C. S. Scearce, C. H. Ehrmann, S. C. Canterano, and N. F. Ness Sep. 1968 76 p refs
(NASA-TMX-63395; X-616-68-370) Avail: CFSTI CSCL 22A

The low power, light weight NASA-GSFC magnetic field experiment utilizes a mono-axial fluxgate magnetometer. The sensor is mounted on one of three transverse booms 2.1 meters from the spin axis and is perpendicular to the boom axis and at an angle of 54° 45' to the spin axis. Three samples are taken at equal intervals during one spacecraft rotation to yield three independent measurements which are mutually orthogonal and thus define the total vector magnetic field. The magnetometer dynamic range is $\pm 64\gamma$ for Pioneer 6 and $\pm 32\gamma$ for Pioneer 7 yielding a resolution of $\pm 0.25\gamma$ and $\pm 0.125\gamma$ respectively. Pioneer 8 incorporates an automatic inflight range switch between two scales of $\pm 32\gamma$, and $\pm 96\gamma$ for a resolution of $\pm 0.125\gamma$ and $\pm 0.375\gamma$. The accuracy of the experiment is limited by spacecraft associated magnetic fields and the zero drift of the sensor. A nonmagnetic explosive actuated indexing device is used to reorient the fluxgate magnetometer by 180° to determine its zero level. The accuracies are estimated to be $\pm 0.25\gamma$, $\pm 0.35\gamma$, and $\pm 0.15\gamma$ respectively. A special purpose digital computer was developed to compute time averages when the spacecraft was not transmitting data in real time or was operating at a low bit rate. Author

**N69-13235#** Oulu Univ. (Finland). Aarne Karjalsinen Observatory.
**SURFACE PHOTOMETRY OF THE PLANET MERCURY**
K. A. Haemeen-Anttila Helsinki Suomalainen Tiedeakat. 1967 21 p refs *Its* Publ. No. 11; Ann. Acad. Scientiarum Fennicae, Ser. A, VI. Phys. 252
Avail: CFSTI

Surface brightness along the photometric equator of Mercury has been measured from four photographs of this planet. A theoretical analysis of the resulting brightness curves shows that the surfaces of the Moon and Mercury are composed of similar materials, but that Mercury's surface is less rough than the Moon's. Author

**N69-13239#** Centre National de la Recherche Scientifique, Marseilles (France). Lab. d'Astronomie Spatiale
**INTERFEROMETRIC STUDY OF IONIZED HYDROGEN IN M 33: NEW KINEMATICAL AND PHYSICAL DATA**
G. Carranza (Observatorio de Cordoba), Y. Georgelin, G. Monnet, and A. Pourcelot [1968] 39 p refs *Its* Publ. de l'Observatoire de Haute-Provence, vol. 9, no. 30
Avail: CFSTI

The radial velocities of 1048 points over M 33 have been obtained by an interference method, using $H_\alpha$ and [N II] lines, with a mean dispersion of 22 Å/mm. A general field of hydrogen not linked to the arms of M 33 (called "disk component") has been traced up to 15' from the nucleus. The large number of points observed yield the following results:—The rotation curve of the disk has been obtained, the expansion motions found are insignificant (< 3 km/s).—A velocity discontinuity of 15 km/s has been found between the general field and the arms, with the arms rotating faster than the disk. The velocity dispersion, small for the arms ($\sigma \simeq 9$ km/s), even smaller in the disk ($\sigma \simeq 6$ km/s), proves that the ionized hydrogen belong to an extreme population I. The rotation curves, obtained for the arms up to 25' from the center, show a 40 km/s diasymmetry between the northern and southern

arms.—The mass density as a function of distance from the center has been obtained up to 7'5 from the nucleus.—The ratio $H_\alpha/[N\ II]$, which has been obtained in the disk up to 15' from the nucleus, is lower than it is in the arms. This suggests a high electron temperature in the disk. Author

**N69-13274*#** Michigan Univ., Ann Arbor.
**ON THE GENERATION OF IDEAL COORDINATE SYSTEMS FOR THE ANALYSIS OF OPTIMAL TRAJECTORIES**
William F. Powers Washington NASA Dec. 1968 24 p refs
(Contract NASr-54(06))
(NASA-CR-1250) Avail: CFSTI CSCL 22C

A relatively well-known property of continuously thrusting optimal trajectories is that there exists a vector constant of the motion which is linear in the Lagrange multipliers. Since the relationship between the corresponding Lagrange multipliers for different sets of state variables is linear, the possibility exists that there is an ideal coordinate system such that three of the associated Lagrange multipliers are constants of the motion. It is shown that such a situation is impossible for more than one of the three constants of the motion. However, a method due to Whittaker is applicable to the problem of generating sets of state variables such that one of the corresponding Lagrange multipliers is a constant of the motion. It is shown that the system of variables generated by cylindrical coordinates possesses this property and, for a large class of problems, the remaining constants of the motion are used effectively to reduce from twelve to nine the number of differential equations which define three-dimensional, optimal trajectories. Author

**N69-13277#**
**ESTIMATES OF THE LOWER BOUNDARY AND THICKNESS OF THE CLOUD LAYER ON VENUS**
A. M. Obukhov and G. S. Golitsyn [1968] 8 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 6, no. 5, 1968 p 759–764
Avail: CFSTI

Estimates are given on the lower boundary and thickness of the cloud layer in the Venus atmosphere for two limiting cases of the ratio between the partial pressure of water vapor and the total atmospheric pressure, 0.7 and 0.1%, on the basis of results of a determination of the chemical composition of the Venus atmosphere and of the temperature and pressure profiles obtained on the Venera 4. It is shown that the lower cloud boundary is at an altitude on the order of 35 km above the surface of the planet. Profiles of the water content in the clouds are calculated. The temperature of the Venus stratosphere is taken as 200° K. The upper boundary of the cloud layer turns out to be near the level of the Venus tropopause, at about 42–43 km altitude. Because of the low temperatures, the cloud should consist mainly of ice crystals, but supercooled water may also exist in its lower portion. Author

**N69-13300*#** Michigan Univ., Ann Arbor.
**COMPUTER MECHANIZATION OF REENTRY EQUATIONS WITH FOUR DEGREES OF FREEDOM**
R. M. Howe Washington NASA Dec. 1968 14 p refs
(Contract NASr-54(06))
(NASA-CR-1249) Avail: CFSTI CSCL 22C

An effective method for controlling the flight path of a vehicle during reentry into the atmosphere is to utilize aerodynamic lift forces. By controlling the bank angle of the vehicle the lift force vector can be directed upwards or downwards to effect the down-range impact point, or sidewards to effect the cross-range impact point. In computing trajectories for such vehicles there are fundamentally four degrees of freedom which must be represented. These are the three translational degrees of freedom and one rotational, namely the roll motion. In solving the translational equations for reentry there are sizable computing advantages in using a modified flight-path axis system called the H-frame. The purpose of this report is to add the fourth degree of freedom to these equations in order to allow the trajectory computation for lifting reentry vehicles with controlled bank angle. Author

**N69-13367#** Oulu Univ. (Finland) Aarne Karjalainen Observatory.
**RADIATIVE TRANSFER IN RELATIVISTIC MEDIUM**
K. A. Hameen-Anttila Helsinki Suomalainen Tiedeakatemia 1967 25 p refs Ann. Acad. Scientiarum Fennicae Ser. A 6 Phys. (Rept.-251) Avail: CFSTI

The theory of radiative transfer is developed in a general-relativistic form. The transformation equations derived for radiation quantities show that Kirchhoff's law relating the coefficients of emission and absorption is an invariant law, if written in an appropriate fashion. Tolman's law for the equilibrium distribution of temperature turns out to be a special case of a more general law. A correction term for nuclear energy production in supermassive stars is derived. Author

**N69-13455*#** Volt Information Sciences, Inc., Washington, D. C.
**ZOND-6 TAKES PHOTOGRAPHS**
Greenbelt, Md. NASA. Goddard Space Flight Center 3 Dec. 1968 7 p Transl. into ENGLISH from Pravda (Moscow), no. 336, 1 Dec. 1968
(Contract NAS5-12487)
(NASA-CR-97934; ST-PR-10781) Avail: CFSTI CSCL 22A

Photographs taken in flight by "ZOND-6" in the course of two sessions are published and are described. The aerophotocamera used had a 400 mm focal distance and the cadre format was 13 by 18 cm. Author

**N69-13473*#** Reilly Translations, Los Angeles, Calif.
**PERSPECTIVES OF AEROGRAPHY BASED ON PHOTOGRAPHIC DOCUMENTS AND ON VISUAL OBSERVATIONS**
G. DeMottoni 1968 10 p refs Transl. into ENGLISH from Italian conf. paper Presented at Ital. Astron. Soc. Conv., Padua-Asiago, 7–9 Oct. 1967 Prepared for JPL
(Contract NAS7-100)
(NASA-CR-97874) Avail: CFSTI CSCL 03B

Seasonal and secular variations on the planet Mars are discussed. These studies are based on mapping compiled from a wide range of photographic documentation and visual observation. Evidence of Martian seasonal variations is presented from observation of seven successive oppositions from 1907 to 1920 showing the planet passing through all seasonal conditions. Secular type variations are distinguished by comparison of three oppositions of 1907-1909-1911 and 1954-1956-1958 which represent identical Martian seasonal times although separated by 25 Martian years. Modifications and developments of several Martian surface features are described in connection with each review. D.H.B.

**N69-13515#** Centre National de la Recherche Scientifique, Marseilles (France). Lab. d'Astronomie Spatiale.
**THE 'MINISIS' EXPERIMENT [PROGRAMME DE L'EXPERIENCE 'MINISIS']**
May 1968 19 p In FRENCH
(Rept-68.PG03) Avail: CFSTI

The proposed experiment aims at exploring, in the best conditions of contrast, the sky in the neighborhood of the sun, to draw the isophotes of the interplanetary diffusion, and to study its interaction with solar wind and the modifications of the brightness as a function of solar activity. ESRO

N69-13537# **FROM THE MOON TO EARTH—INTERVIEW WITH ACAD. G. I. PETROV**
B. Konovalov [1968] 4 p Transl. into ENGLISH from Izv. (Moscow), no. 271(15970), 19 Nov. 1968
Avail: CFSTI

A news release of an interview with G. I. Petrov, Soviet specialist in aerodynamics and space research, is presented. The topics covered are: (1) peculiarities of earth reentry of a probe moving at the second cosmic velocity; (2) controlled descent using aerodynamic quality; (3) solution of atmospheric reentry at the second cosmic velocity in laboratories; and (4) value of solving earth reentry problem for vehicles flying at second cosmic velocity, and of descent with aerodynamic quality to subsequent mastery of space. B.P.

N69-13550*# Maryland Univ., College Park. Dept. of Physics and Astronomy.
**OBSERVATIONS OF AN INCREASE IN THE FLUX FROM TAU A D DURING OCCULTATION BY THE SOLAR CORONA**
W. C. Erickson [1968] 16 p refs
(Grant NSG-615)
(NASA-CR-97929) Avail: CFSTI CSCL 03B

During the June, 1965, occultation by the solar corona, the radio source Tau A was observed at wavelengths of 74 and 128 cm with the NRAO 300' antenna. Little change in the flux at 74 cm was observed, but at 128 cm the flux increased by 30% during the occultation. Various explanations of this flux increase are considered, but none are found to be very satisfactory. Author

N69-13727# Joint Publications Research Service, Washington, D. C.
**ASTRONOMY**
*In its* Soviet-Bloc Res. in Geophys., Astronomy, and Space 29 Nov. 1968 p 1-6 (See N69-13726 03-34)
Avail: CFSTI

A news release discussing the nature of the Martian surface is presented. Abstracted articles on astronomy research are also included and mentioned below. A study was made of the static properties of solar granules. Correlation theory was used for describing the random nature of the granule field. X radiation during the accretion of interstellar matter by neutron stars was studied. Spectrophotometric gradients were determined for the components of ten eclipsing binaries whose satellites are typical subgiants. The motion of a satellite of a spheroidal planet in a planetocentric coordinate system was examined. The diffusion of comets in the solar system was described by solving a differential equation. B.P.

N69-13754*# Analytical Mechanics Associates, Westbury, N. Y.
**LAMBERT'S PROBLEM AND CROSS-PRODUCT STEERING**
Quarterly Report
William E. Moore Apr. 1967 7 p refs
(Contract NAS9-4038)
(NASA-CR-92419; QR-9; REPT-67-8) Avail: CFSTI CSCL 22C

Formulas are presented for solving Lambert's problem in the case of only single orbits. Other formulas are given for the derivatives of several parameters when the initial positions change in accordance with a given velocity vector and a fixed terminal position and time. Author

N69-13777*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**SURVEYOR 1 MISSION REPORT. PART 2: SCIENTIFIC DATA AND RESULTS**
L. D. Jaffe, E. M. Shoemaker, S. E. Dwornik, J. J. Rennilson, J. L. Dragg et al 10 Sep. 1968 109 p refs
(Contract NAS7-100)
(NASA-CR-97898; JPL-TR-32-1023-PT-2) Avail: CFSTI CSCL 22A

Details of the spacecraft configuration and camera are shown. Assessments of the lunar surface topography, lunar surface thermal characteristics, and lunar surface electrical properties are made. Over 11,000 lunar pictures were taken by TV camera during the two lunar days after Surveyor 1 landed in a smooth mare surrounded by hills and mountains visible along the horizon. The analyses show that the surface is composed of granular materials of a wide size range, and the lunar surface is compared qualitatively to that of a damp, fine grained terrestrial soil. Solar photographs made from the lunar surface showed corona out to 3 or 4 solar radii. The possible scattering of sunlight from a lunar atmosphere is being investigated. F.O.S.

N69-13804# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
**ON THE SEPARATION OF MATTER AND ANTIMATTER IN AN EXPANDING UNIVERSE**
R. L. Omnes Oct. 1968 7 p refs
(Rept-68-29) Avail: CFSTI

It is shown that the problem of matter formation and possibly its separation from antimatter in the Gamow cosmological model can be stated as a problem in strong interaction physics. A proposal for this process is made which is based on the properties of the pion-nucleon interaction. Author

N69-13844*# National Aeronautics and Space Administration, Washington, D. C.
**OBJECTIVES AND GOALS IN SPACE SCIENCE AND APPLICATIONS 1968**
John E. Naugle 1968 97 p refs
(NASA-SP-162) Avail: SOD $1.50; CFSTI CSCL 22

The objectives, current programs, and future mission options developed during planning efforts to integrate program activities on a NASA-wide basis are presented in synoptic, nontechnical form. The main areas considered pertain to space physics, astronomy, lunar exploration, planetary exploration, bioscience, and space applications. Several viewpoints are included on the relative emphasis which should be placed on future program options. M.G.J.

N69-13862# Joint Publications Research Service, Washington, D. C.
**FUTURE OF RADIO ASTRONOMY SURVEYED**
N. L. Kaydanovskiy 9 Dec. 1968 25 p Transl. into ENGLISH from Priroda (Moscow), Aug. 1968 p 34-43
(JPRS-47029) Avail: CFSTI

This nontechnical presentation notes the extraordinary growth being experienced currently by astronomy, the associated expanding engineering possibilities, and the important role of radio astronomy. Radio astronomy provides many technical advantages as a powerful tool for astronomical progress. The mechanical and electromagnetic characteristics of radio astronomy are discussed briefly, and several modern radio telescope installations are described including the Pulkovo telescope with a variable profile antenna system. Capabilities of the Pulkovo telescope are exemplified by studies in fine structure brightness and polarization of numerous galactic and metagalactic sources which have allowed precise coordinates determination of those bodies. Observation of Venusian edge darkening permitted prediction of a Venusian atmosphere model which was later verified by a Venus probe. Polarization of lunar emission was observed which facilitated an evaluation of lunar surface characteristics. D.H.S.

**N69-13870*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**RESEARCH ACHIEVEMENTS REVIEW. VOLUME 3: ASTRODYNAMICS, GUIDANCE AND OPTIMIZATION RESEARCH AT MSFC**
1968 47 p refs
(NASA-TM-X-53777; Rept.-2) Avail: CFSTI CSCL 22C

Three of the topics to be discussed bear a close relationship to each other. From an analytical point of view, the most general of the three is the paper on orbits in noncentral force fields. The discussion of the motion of an artificial satellite under the combined influence of planar and Keplerian force fields is a special case of the more general theory being examined. While these two articles are entirely analytic, the third in this series represents the problem of generating interplanetary trajectories numerically by using interplanetary integrating computer programs. The remaining two presentations are related to guidance. One paper presents a fairly broad class of guidance concepts with emphasis on optimization, while the other paper deals specifically with the problems of rendezvous guidance techniques. Author

**N69-13887#** Joint Publications Research Service, Washington, D. C.
**RADIOBIOLOGICAL EXPERIMENTS ON COSMOS-110 BIOSATELLITE**
V. V. Antipov et al 29 Nov. 1968 31 p refs Transl. into ENGLISH from the Russian
(JPRS-46977) Avail: CFSTI

Details are given on the results of the experiments conducted on the Cosmos 110 biosatellite to determine the biological effects of radiation on lysogenic bacteria *E. coli* K-12 (lambda), microspores of *Tradescantia*, the dry seeds of certain higher plants, various strains of chlorella, and an intact plant of *Tradescantia paludosa*. According to onboard dosimetry data, the integral dose of cosmic radiation was 12 rad at an average dose strength of 500 millirad/day. It is pointed out that the main contribution to the dose was not primary cosmic radiation but the emission of the earth's radiation belts. The effects of weightlessness in this experiment continued for about 22 days. Physiological, cytogenetic, genetic, and microbiological methods were used in the evaluation. The analyses show that despite a larger radiation dose than in preceding flights and longer exposure to weightlessness, the results do not differ appreciably from the biological flights of the Vostok and Voskhod spacecraft. Physiological shifts were recorded in germination of seeds and several breakages of hereditary structures were observed; however, the values of these shifts proved to be small. M.G.J.

# 31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

**N69-13182#** Library of Congress, Washington, D. C. Aerospace Technology Div.
**THE SOYUZ-3 MISSION**
Boris Mandrovsky *In its* Foreign Sci. Bull., Vol. 4, No. 12 Dec. 1968 p 4-24 refs (See N69-13181 03-34)
Avail: CFSTI

Data published in the Soviet press between 27 October and 6 November, 1968, on the successful flights of the Soyuz-3 are presented. Information is included on maneuvers in orbit, rendezvous with Soyuz-2, aerodynamic descent, Soviet comments on design, systems, and capabilities of the Soyuz spacecraft, and the biomedical aspects of the Soyuz-3 flight. Author

**N69-13217*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**SURVEYOR 1 MISSION REPORT. PART 1: MISSION DESCRIPTION AND PERFORMANCE**
R. J. Parks 31 Aug. 1966 181 p refs
(Contract NAS7-100)
(NASA-CR-97893; JPL-TR-32-1023-PT-1) Avail: CFSTI CSCL 22B

A technical description of the mission and an evaluation of the engineering results are presented. The spacecraft assembly, preflight testing, and launch site operations are reviewed, and the launch phase real time mission analysis is included. The Atlas/Centaur vehicle and launch vehicle/spacecraft interface are described, along with the subsystems for flight control, propulsion, tracking, and separation. Details are given on the Surveyor instrumentation, structures, and mechanisms; and on the thermal, flight, and electric power systems. The tracking and data acquisition supporting functions are outlined for the Air Force Eastern Test Range, Goddard Space Flight Center, and the Deep Space Network. The mission operations system and system personnel duties are described, and the mission dependent equipment are indicated. A discussion is also presented on the flight path, midcourse maneuvers, and landing of the spacecraft. The sequence of events, spacecraft configuration, and spacecraft temperature histories are also included. N.E.N.

**N69-13232*#** National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
**POSTFLIGHT OPTICAL EVALUATION OF THE RIGHT-HAND AND LEFT-HAND WINDOWS OF GEMINI MISSIONS 4, 5, 6, AND 7**
George P. Bonner, Michael F. Heidt, Carl L. Kotila, John A. Lintott, John E. Novotny et al Washington Dec. 1968 50 p
(NASA-TN-D-4916) Avail: CFSTI CSCL 22B

Transmission and relative resolution measurements were made before cleaning, and transmission, schlieren, relative resolution, and interferometric measurements were made after cleaning, on the right-hand and left-hand windows of Gemini spacecraft G-IV to G-VII. Chemical analyses of the contamination cleaned from the windows show that the primary constituent is amorphous silica. Author

**N69-13236*#** Whittaker Corp., San Diego, Calif. Research and Development Div.
**DESIGN AND CONSTRUCTION OF AN EXPANDABLE AIRLOCK**
Kenneth R. Berg [1968] 107 p refs
(Contract NAS1-5752)
(NASA-CR-66709) Avail: CFSTI CSCL 22B

An expandable airlock structure was designed, built, and tested by Whittaker Corporation, Research & Development Division/San Diego as an engineering model to be used by NASA-Langley engineers to determine the feasibility of an isotensoid structure for an airlock function. The design utilized the latest in flexible structural fabric materials and an isotensoid design for maximum structural efficiency. High efficiency glass reinforced epoxy was used in the hatch door and skirt. The design operating pressure is 15 psig with an ultimate burst pressure design strength of 50 psig. The airlock was proof pressure tested to 29.4 psig without damage. A retraction mechanism allows minimum volume storage when not in use. Author

**N69-13429#** National Environmental Satellite Center, Washington, D. C.
**COMPUTER PROCESSING OF TOS ATTITUDE DATA**
J. F. Gross Nov. 1968 14 p refs
(NESCTM-6) Avail: CFSTI

This memorandum describes the computer program used operationally at the National Environmental Satellite Center (NESC) to determine the attitude of a Tiros Operational Satellite (TOS). It includes background information of historical interest, specific details of the problem and its solution, and thoughts about future approaches. It is intended as a description of this part of the NESC operation and as an introduction to the more esoteric program documentation. Author

**N69-13501#**
**TASS REPORT: ON THE ROAD TO ORBITAL STATIONS**
[1968] 9 p Transl. into ENGLISH from Krasnaia Zvezda (USSR), no. 269(13708), 17 Nov. 1968
Avail: CFSTI

A brief review is presented of Soviet manned space flights. The flights of the unmanned Soiuz 2 and piloted Soiuz 3 are emphasized. The capabilities of these crafts to perform controlled motion in space, to rendezvous with another space vehicle, and to maneuver in direct proximity to another space vehicle is considered to be of great value in establishing orbital stations. The apparatus for the living and working conditions onboard the Soiuz craft is described, as well as the orientation and motion control system. A brief summary is included of the interaction of the crafts in flight. B.P.

**N69-13507#** Royal Observatory, Edinburgh (Scotland). Satellite Tracking Section.
**STOPWATCH OBSERVATIONS OF SATELLITES, JULY 1968**
R. D. Eberst 12 Aug. 1968 17 p ref
(ROE/STS/79) Avail: CFSTI

Stopwatch observations made at stations connected with the tracking section during the month of July 1968 are listed in satellite launch order and in time order for each satellite. Various subtotals are given. ESRO

**N69-13523#**
**SATELLITES OF THE COSMOS SERIES**
[1968] 10 p Transl. into ENGLISH from the book "USSR Progress in Cosmic Space Research" Moscow, Nauka, 1968 p 496-505
Avail: CFSTI

A press release is presented on the launching of Cosmos satellites since 1962. The scientific research programs of these crafts were designed for studying the charged particle concentration in the ionosphere to investigate radio wave propagation, corpuscular fluxes, and low energy particles; to study the energy composition of the earth's radiation belts in order to estimate radiation hazards for prolonged space flights; and so on. The scientific apparatus used on the Cosmos series is itemized. Brief descriptions are presented of the operational data of selected satellites, namely, Cosmos 1, 2, 3, 4, 7, 8, 11, 17, 19, 23, 26, 51, 97, 106, 110, 122, 144, 149, 156, and 166. The Cosmos satellites were injected into orbit by two, three, and four stage boosters capable of lifting from several hundred kilograms to several tons. The satellite was mounted under the nose fairings of the last stage on a special chassis, and was fastened by using rupturing bolts. Separation of the satellite from the last stage occurred at the end of the orbit injection phase. B.P.

**N69-13524#**
**LATEST STAGE IN THE SOVIET SPACE PROGRAM—DESCENT OF THE "ZOND-6" FROM THE EARTH-MOON-EARTH TRACK**
[1968] 13 p Transl. into ENGLISH from Pravda (Moscow), no. 329(18376), 24 Nov. 1968 p 3
Avail: CFSTI

The Zond 6 probe flew around the moon, and performed a controlled descent to the earth's surface. A news item gives the details of this flight. The Zond 6 was launched by a multistage booster at 2211:30 Moscow time on 10 November 1968, and the probe was injected together with the last stage of the booster into an earth-satellite orbit with the following parameters: minimum distance from earth—185 cm; maximum distance from earth—210 km; orbit inclination to equatorial plane—51.4 deg. A diagram is presented of the maneuvers of the vehicle's reentry into the earth's atmosphere which took place at 1658:00 on November 1968. Radiation investigations using biological objects were carried out aboard the craft, and the scientific values of the experiments are discussed. B.P.

**N69-13685#** Joint Publications Research Service, Washington, D. C.
**ON THE WAY TO ORBITAL STATIONS IN SPACE**
2 Dec. 1968 10 p Transl. into ENGLISH from Krasnaya Zvezda (Moscow), 17 Nov. 1968 p 4
(JPRS-46982) Avail: CFSTI

A brief history of the development of Soviet manned space flight is given. Details are presented on the arrangement of systems on the Soyuz spacecraft, descent, and recovery from orbit. These developments are considered to be steps toward orbital stations. F.O.S.

**N69-13704*#** General Electric Co., Philadelphia, Pa. Missile and Space Div.
**VOYAGER MARS PLANETARY QUARANTINE Basic Math Model Report**
G. E. Ingram, M. Martin, T. Green, and E. Berger 13 Feb. 1967 200 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951112)
(NASA-CR-97896; VOY-C2-TR8) Avail: CFSTI CSCL 22B

The goal of the planetary quarantine study is to show the effects of the planetary quarantine requirements on the Voyager mission and its elements. A simplified work flow diagram showing the major planetary quarantine subtasks and their interrelationship is presented. The fundamental questions and the selected approach to be used in formulating the basic math model are explained. The results of a parametric analysis for orbit mechanics and entry are converted to a form suitable for incorporation into the math model computer programs. An example is given of how the math model is used in performing sensitivity studies. A complete listing of the programs developed for this task is included. K.W.

**N69-13805#** National Research Council of Canada, Ottawa (Ontario). Space Research Facilities Branch.
**BLACK BRANT ROCKET AKF-IV-10 LAUNCHED AT CHURCHILL RESEARCH RANGE, 5 APRIL 1968**
Oct. 1968 24 p refs
(SRFB-016; PD-5417) Avail: CFSTI

The engineering aspects are presented of preparing the payload and the launching of Black Brant rocket AKF-IV-10, during calm geophysical conditions at Churchill Research Range on 5 April 1968. The vehicle carried experiments to measure cosmic X-rays, photon intensity and energy spectrum, ionization density profile and electron density inhomogeneities to a height of 2,833,000 feet (536.5 statute miles), with telemetry and experiments performing as planned. Author

# 32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

**N69-12604** Columbia Univ., New York.
**STRUCTURAL CLASSIFICATION AND TYPE SYNTHESIS OF MECHANISMS WITH MULTIPLE ELEMENTS**
Frank Buchsbaum (Ph.D. Thesis) 1967 233 p
Avail: Univ. Microfilms: HC $10.60/Microfilm $3.05 Order No. 67-15479

The degree of freedom of geared joint has been defined and the degree of freedom characteristics have been analyzed. Equations have been developed which correlate geared kinematic chains to mechanisms with turning joints only. The concept of equivalent linkages has been introduced. Schematic and graph representations of geared kinematic chains have been developed. The term multiple elements implies a mechanism containing different kinds of joints. In this dissertation this fact is illustrated by the simultaneous presence of turning and gear joints. The structural classification and enumeration of geared kinematic chains (commonly known as gear trains, speed reducers or differentials) has been investigated. The methods developed for this purpose are general, and are not limited to this particular combination of elements.
Dissert. Abstr.

**N69-12606** Drexel Inst. of Tech., Philadelphia, Pa.
**AXISYMMETRIC MOTIONS OF NEARLY FLAT SHELLS OF REVOLUTION**
Richard Walter Mortimer (Ph.D. Thesis) 1967 109 p
Avail: Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-14112

A system of linear equations of motion, which includes the effects of transverse shear deformation as well as rotary inertia, is derived for thin, elastic, isotropic shells of revolution. The shell theory derived herein follows closely the cylindrical shell theory which utilizes the centroidal rather than the middle surface as the reference for the rotations and moments of transverse sections. As a result, for axisymmetric motions of nearly-flat shells of revolution (i.e., those with small meridional curvatures), these equations are amenable to solution by the unified approach utilizing the method of characteristics. The reduction of this shell theory to specific examples, and comparison with other theories are presented. Numerical examples of conical and cylindrical shells under impact loadings are included to demonstrate the utility of the theory developed.
Dissert. Abstr.

**N69-12629** Virginia Polytechnic Inst., Blacksburg.
**A STUDY OF LINEARLY VISCOELASTIC ANISOTROPIC SHELL STRUCTURES**
William Buckner Haile, Jr. (Ph.D. Thesis) 1967 130 p
Avail: Univ. Microfilms: HC $6.20/Microfilm $3.00 Order No. 68-2048

A general theory of thin shell structures is presented in tensor notation without regard to any particular shell geometry. The theory allows for a shell of layered construction where any arbitrary number of layers may be anisotropic and linearly viscoelastic. Anisotropy in the layers is handled by treating each layer separately and then summing across the shell thickness to develop certain over-all shell stiffness coefficients. Viscoelasticity in the layers is treated in two ways: first, if the shell is subjected to a static load, the Laplace transform of the constitutive equations is taken so that solutions will be those from an associated elastic problem; and, second, if the shell is subjected to periodic vibrational loads, the time response of the functions is known and the solution becomes that for the proportional loading problem. In the vibrational analysis, all viscoelastic moduli become functions of a complex frequency with a real part representing normal mode damping and an imaginary part corresponding to the actual frequency. Throughout the analysis thermal effects are ignored and large deflections are not included.
Dissert. Abstr.

**N69-12728** University of Southern Calif., Los Angeles.
**THE IMPACT OF A SPHERICAL SHELL ON AN ELASTIC SURFACE**
Neil Edward Johnson (Ph.D. Thesis) 1967 233 p
Avail: Univ. Microfilms: HC $10.60/Microfilm $3.05 Order No. 68-1683

An analysis of the problem of the normal impact of a spherical shell against a deformable surface is presented. The contact stresses and deformations and the response of the shell have been determined. The analysis is based on the assumptions of a thin shell, small deformations, and stresses within the elastic range and smaller than their critical buckling values. The impacted surface is assumed to be an elastic medium of the Winkler type. Two shell theories have been considered; the membrane theory and the bending theory with transverse shear and rotatory inertia taken into account. At the instant of impact the shell has a given velocity normal to the impacted surface. Solutions of the problem have been obtained through the use of the normal mode expansion method and the method of characteristics for both the membrane and bending-shear theories. From the mathematical point of view, the subject of this paper belongs to a class of boundary-value problems of elasto-dynamics that have not received much investigation. These problems, the problems of dynamic contact between two elastic bodies, are characterized by a time-dependent coupling of contact stress and displacement. It is apparent that the methods used in this investigation could be extended to shells of other geometries and both shells and contact surfaces of other properties.
Dissert. Abstr.

**N69-12749** Kansas Univ., Lawrence.
**COMPUTER ANALYSIS OF ELASTIC-PLASTIC TWO DIMENSIONAL RIDGEJOINT FRAMES**
V. S. Varadachary (Ph.D. Thesis) 1967 132 p
Avail: Univ. Microfilms: HC $6.40/Microfilm $3.00 Order No. 68-643

Computer analysis of elastic-plastic two dimensional rigid-joint frames is presented using the displacement (stiffness) approach. The concept of matrix transformation is used to elastically analyze two-dimensional frames. The mathematical background and computational details are explained with a flow chart. Eccentric-joint two dimensional frames are analyzed, and the fundamental concepts of plasticity are introduced by means of a simple example. Plastic bending and concepts of plastic moment and plastic hinge are described with their assumptions and limitations, followed by plastic analysis and the determination of collapse load for rigid frames. The analysis includes the axial deformation effects that are neglected in existing methods of collapse load analysis and is applicable to various types of frames. The Fortran IV source listing is included and could be adopted to any computer facility with a Fortran IV compiler.
Dissert. Abstr.

**N69-12764** Wisconsin Univ., Madison.
**GENERAL SECOND-ORDER AND STABILITY ANALYSIS OF RIGID FRAMES**
Qassim M. Al-Mawsawi (Ph.D. Thesis) 1967 189 p
Avail: Univ. Microfilms: HC $9.00/Microfilm $3.00 Order No. 67-12404

A general approach to the elastic-plastic second-order and stability analysis of rigid frames in the presence of primary bending moment is presented. In this approach, the flexural stiffness at each member end is taken as a function of the axial force in the member. Furthermore, the equilibrium equations are based on the shape of the deformed structure, while Hooke's law is applied between the original and the final configuration. The criterion for instability is shown to be associated with the divergence of the column vector of the external displacements. Two computer programs have been developed. The first program gives a complete elastic second-order analysis and also a direct method of estimating the elastic critical load of the given rigid frame. The second program provides a step-by-step second-order limit analysis of any rigid frame under a set of proportionate loads. A number of solved examples are included. Finally, the current methods of estimating the amplification of bending moment due to the axial force, and of obtaining the elastic and inelastic critical loads are examined. Dissert. Abstr.

**N69-12783** Iowa State Univ. of Science and Technology, Ames.
**VIBRATION FREQUENCIES OF A FREE-FREE CYLINDRICAL BEAM OF FINITE LENGTH IMMERSED IN AN INVISCID FLUID**
Antonio Pita-Szczesniewski (Ph.D. Thesis) 1967 70 p
Avail: Univ. Microfilms: HC $3.80/Microfilm $3.00 Order No. 68-967

Free vibrations of an elastic bar of circular cross-section and finite length which is immersed in an inviscid fluid contained in an infinite cylindrical duct, are studied. The vibration is assumed to be of small amplitude and the end conditions of the bar are taken to be free. The fluid region is divided into three parts and velocity-potential expressions, in terms of Bessel functions, are derived for each part. The velocity potentials and their normal derivatives are required to be continuous at the interfaces between the various fluid regions. The motion of the fluid is then incorporated into the system through its kinetic energy and the technique of Rayleigh–Ritz is employed to evaluate the natural frequencies of vibration. Final results are then compared with those obtained by other methods. Dissert. Abstr.

**N69-12789** University of Southern Calif., Los Angeles.
**WAVE PROPAGATION IN ELASTIC AND ELASTIC-PLASTIC CYLINDRICAL SHELLS**
Samy Aly Adham (Ph.D. Thesis) 1967 229 p
Avail: Univ. Microfilms: HC $10.35/Microfilm $3.00 Order No. 68-1674

This paper investigates the axially symmetric waves in cylindrical shells. The equations for elastic, elastoplastic, and viscoelastic shells are developed and applied. Several boundary conditions and input functions are considered. Solutions were obtained by both the normal mode expansion method and by the method of characteristics. Numerical examples are given, and the physical significance of the results is discussed. These are then compared to previous work on this subject. Dissert. Abstr.

**N69-12798** Virginia Polytechnic Inst., Blacksburg.
**THE DIRECT DETERMINATION OF NONLINEAR DISPLACEMENTS OF ARBITRARILY SUPPORTED SHALLOW SHELLS USING MATHEMATICAL PROGRAMING TECHNIQUES**
Harry George Scheaffer (Ph.D. Thesis) 1967 154 p
Avail: Univ. Microfilms: HC $7.20/Microfilm $3.00 Order No. 68-2071

The nonlinear behavior of an axisymmetrically loaded shallow shell of revolution with arbitrary edge conditions is investigated. The approach used in the present investigation is to obtain the displacement set which minimizes the finite-difference approximation of the shell potential energy by using mathematical programing techniques. Results of the present investigation are compared with published data for the buckling of a uniformly loaded clamped spherical cap. Additional results are presented which show the effect of changes in edge restraint and changes in shell geometry on the buckling pressure for uniformly loaded shallow shells. Dissert. Abstr.

**N69-12846** Stanford Univ., Calif.
**UNIFIED THEORY FOR NONLINEAR BENDING AND BUCKLING OF SANDWICH SHELLS. (APPLICATION TO BUCKLING OF CIRCULAR CYLINDERS IN AXIAL COMPRESSION)**
Geert Bartelds (Ph.D. Thesis) 1967 121 p
Avail: Univ. Microfilms: HC $6.00/Microfilm $3.00 Order No. 67-17393

A variational development of the governing equations and boundary conditions for the bending and buckling of sandwich curved plates and shells is presented. The theory is applicable to sandwich construction of the honeycomb type and may be utilized to describe bending, buckling and postbuckling behavior. With the coupled effects of core transverse shear and normal strain included, the theory reflects the presence of eight degrees of freedom and two constraining conditions. Nine boundary conditions per curved plate or shell edge can be specified; apart from the four of the usual type for each of the sandwich facing elements, in terms of either a generalized force or displacement, a condition for either the shear loading or the average displacement of the core is obtained. The governing equations, specialized for small displacement buckling, are applied to the case of axial compression of circular cylindrical shells. The unified theory analysis reflects three modes of buckling, classical general instability, and both symmetric and antisymmetric wrinkling. Dissert. Abstr.

**N69-12848** Kansas Univ., Lawrence.
**CRACK MOTION IN PLANE ELASTIC BODIES**
Donald Otis Swenson (Ph.D. Thesis) 1967 108 p
Avail: Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 68-639

An energy approach to crack propagation is used by establishing the action functional of the work and elastic energy field due to the external body forces and to the crack's existence. The infinite elastic body is in a plane strain configuration in which the only inelastic strains occurring are within the defined crack surface and are due to cohesive forces. By performing the first variation of the action functional, the dynamic crack equation is established which has infinite degrees of freedom. By considering only the motion of the crack's center and the length of the crack, the degrees of freedom are reduced to two equations. Static crack models are found to satisfy the two equations identically. Broberg's crack model with constant crack tip propagation velocities only satisfies the two equations with the tip velocity equal to zero or $C_1$. With Yoffe's constant length, constant velocity propagating crack model the equations are satisfied identically. A modified version of Yoffe's crack model in which the length is varied satisfies the equations for velocities of zero and $\approx 0.8\ C_2$. Another modified version of her model satisfies the equations for velocities of zero or $\approx 0.8\ C_2$ if the load is varied slowly in order to neglect the inertial forces due to the load change. Dissert. Abstr.

**N69-12864** IIT Research Inst., Chicago, Ill.
**BUCKLING OF FOLDED PLATES**

Stuart Endsley Swartz (Ph.D. Thesis) 1968 173 p
Avail: Univ. Microfilms: HC $8.00/Microfilm $3.00 Order No. 67-17718

Folded plates subjected to uniform live load were analyzed to determine the local buckling of individual elements. Because of approximations used in the available stress analyses for folded plates the buckling problem was simplified by assuming the instability of a plate to be caused by either transverse in plane forces or a combination of shearing and longitudinal in plane forces. Both analyses were based upon an application of the principle of conservation of energy as proposed by Rayleigh and used the small deflection folded plate theory of Goldberg and Leve. Computer programs were written in FORTRAN IV for use on the IBM 7040 and IBM 360-40 machines to perform the necessary numerical operations. Theoretical buckling loads were computed for full size concrete folded plate roofs and small aluminum roof models and curves of buckling loads versus length were plotted for each structure. Dissert. Abstr.

**N69-12870#** Ballistic Research Labs., Aberdeen Proving Ground, Md.
**CONSTITUTIVE EQUATIONS DEVELOPED FROM IMPACT STUDIES**
William J. Gillich Sep. 1968 37 p refs
(AD-676110; BRL-1416) CSCL 20/2

It was discovered through free flight impact tests using specimens traveling at a constant velocity prior to impact that one form of the deformation curve for high purity aluminum and copper single crystals could be represented as a 1/4-power law. This particular deformation law as found to be predictable using the stress and strain ratios of the aggregate theory of Taylor. These predictions were made on the basis of the deformation of polycrystalline metals. A generalization of the 1/4-power law constitutive relation is shown to account for uniaxial deformation that occurs for both single crystal and polycrystalline specimens subjected to static or dynamic deformations. This formulation is related to the parabolic type of constitutive development proposed by Bell. Author (TAB)

**N69-12953** California Univ., Berkeley.
**APPLICATION OF WEIBULL'S STATISTICAL THEORY OF STRENGTH TO PREDICT FRACTURE AND VOLUME REMOVAL IN BRITTLE SOLIDS**
Hilario Lim Oh (Ph.D. Thesis) 1967 150 p
Avail: Univ. Microfilms: HC $7.00/Microfilm $3.00 Order No. 68-129

Brittle materials fail at stresses well below the theoretical fracture strength. Brittle materials also exhibit a wide dispersion of strength with the mean strength increasing with decreasing specimen size. Weibull explained these observations by noting that flaws could vary in size in which case the strength of a solid would depend upon the probability of it containing a severe flaw. Predictions of fracture strength thus require a statistical description of flaw size. In this investigation, this approach is applied to predict fracture in glass and to estimate volume removal in processing operations on brittle materials. It is also shown in this investigation that Weibull's statistical theory can be extended to account for a hitherto unexplained phenomenon: that fracture does not occur at the location of maximum tensile stress. The analysis predicts mean fracture locations which are in good agreement with values observed in the fracture of glass by spherical indenters. Dissert. Abstr.

**N69-13034*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**BUCKLING OF AN EQUATORIAL SEGMENT OF A SPHERICAL SHELL LOADED BY ITS OWN WEIGHT**
Robert E. Blum and Harvey G. Mc Comb, Jr. Washington Dec. 1968 29 p refs
(NASA-TN-D-4921) Avail: CFSTI CSCL 20K

Buckling equations are solved for a simply supported equatorial segment of a spherical shell loaded in the axial direction by its own weight. The Galerkin method is used to obtain a critical-thickness parameter for buckling as a function of the shell material and geometric properties and of the relative proportions of the shell weight supported at the upper and lower edges. Results of the present method are compared with those of a simplified approach in which the spherical shell segment is assumed to buckle if the maximum compressive stress is greater than the critical compressive stress for a complete spherical shell loaded by uniform external pressure. This comparison indicates that the simplified approach yields larger thicknesses than the method presented here. The particular proportions of the shell weight which should be supported at the upper and lower edges to minimize the tendency to buckle are also determined. Results have been used in the design of a large rectangular reinforced-plastic shell segment which simulates the lunar surface in the lunar orbit and landing approach simulator. Author

**N69-13083** Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering.
**BUCKLING OF CYLINDRICAL SHELLS UNDER LONGITUDINAL SHEAR LOADS**
Menahem Baruch and Ovadia Harari Nov. 1967 33 p refs Supported by Gerard Swope Found.
(AE-38; TN-1) Avail: CFSTI

The stability of simply supported cylindrical shells under uniform longitudinal shear and/or uniform axial compression is investigated for four types of in-plane boundary conditions. The assumed displacements solve the first two stability equations while the third one is solved by a Galerkin procedure. It was found that, as in the case of axial compression, the critical longitudinal shear load for the weaker circumferential boundary conditions ($N_{x\theta}$ = 0) is about half of that of "classical" boundary conditions. Author

**N69-13160*#** Brown Engineering Co., Inc., Huntsville, Ala.
**TWO HUNDRED-INCH MULTICELL TANK SLOSH TESTS**
Francis H. Cooper 29 Nov. 1968 87 p
(Contract NAS8-20073)
(NASA-CR-61244; CI-SST-4-006) Avail: CFSTI CSCL 13D

This test was conducted to determine the first resonant slosh frequency and related data with water levels at 1/2 and 3/4 full. Data obtained include horizontal shaker loads and displacements, vertical load changes on the 10 supports, and pressures and strains on the cell walls. Author

**N69-13241#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ENGINEERING JOURNAL (SELECTED ARTICLES)**
31 Oct. 1967 25 p refs Transl. into ENGLISH from Inzhenernyy Zh. (USSR), v. 5, no. 4, 1965 p 685-696
(AD-673921; FTD-HT-23-729-67) Avail: CFSTI CSCL 13/13

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**N69-13242#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**LESSER FREE VIBRATIONS OF ELASTIC SHELLS OF ROTATION [MALYYE SVOBODNYYE KOLEBANIYA UPRUGIKH OBOLOCHEK VRASHCHENIYA]**

G. I. Pshenichnov *In its* Eng. J. 31 Oct. 1967 p 1–7 refs (See N69-13241 03-32)

Avail: CFSTI

The free vibrations of elastic surfaces (shells) of revolution are considered. The system of equations for the free vibrations is obtained by assuming harmonic vibrations where eigenvalues ω and eigenfunctions U, V, and W of the differential equations are sought for boundary conditions. By using an asymptotic integration method the functions U, V, and W can be determined after assuming that they consist of the sum of two terms corresponding to the solutions of the approximate equations (shell thickness → 0) and the large variation equations. It is shown that vibrations exist for which the frequencies and the tangential displacement functions (u,v) can be obtained from the dynamic analog of the static, no-moment equations and the tangential boundary conditions. It is also indicated that for a range of vibrations the frequencies and bending function (w) can be found from the dynamic analog of the static stress equations and the nontangential boundary conditions. Author

**N69-13243#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**AXISYMMETRICAL VIBRATIONS OF A GAS IN A CYLINDRICAL CONTAINER WITH THE TAKING INTO ACCOUNT OF THE ELASTICITY OF ITS END WALL [OSESIMMETRICHESKIYE KOLEBANIYA GAZA V TSILINDRICHESKOY POLOSTI S UCHETOM UPRUGOSTI YEYE TORTSOVOY STENKI]**

V. M. Lyubimov *In its* Eng. J. 31 Oct. 1967 p 8–15 refs (See N69-13241 03-32)

Avail: CFSTI

The axisymmetric vibrations of a gas in a container having rigid walls except for one end wall (which is considered as a clamped elastic plate) are considered. The differential equations and boundary conditions for the gas and plate vibrations are derived by using nondimensional coordinates. It is shown that the simultaneous solution to the gas and plate equations can be expressed in terms of a series; the error introduced into the frequency calculations by truncating the series is evaluated. The two special cases in which the mathematical solutions simplify are considered, but the physical significance of these mathematical simplifications is not discussed. Author

**N69-13250*#** North American Rockwell Corp., Downey, Calif. Space Div.

**MASS LOADING EFFECTS ON VIBRATION OF RING AND SHELL STRUCTURES**

S. Y. Lee, S. S. Tang, and J. G. Liyeos Feb. 1968 126 p refs (Contract NAS8-20019)

(NASA-CR-98508; SD-68-29) Avail: CFSTI CSCL 20K

The series expansion technique was used in solving the mass loaded shell problem, while both the finite-element and transfer-matrix methods were employed in the analysis of mass loaded ring structures. Aluminum ring and shell structures loaded with a series of discrete masses were excited by a magnetic induction method. The vibratory motion was measured by an automatically revolving proximity gage. Response data were obtained with miniature accelerometers as well as a proximity gage. Amplitude changes of the local vibration response were caused by the addition of the discrete masses; frequency shifts, change of modal behavior and transmissibility characteristics resulted from the increased discrete mass of the structure. The procedure currently recommended by NASA/MSFC for predicting the amplitude reduction of the local vibration response of an unloaded structure, to account for the influence of the addition of the masses, provides a fair approximation in the first vibration mode, but is overly conservative for higher modes. Author

**N69-13383#** Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

**APPLICATION OF IMPEDANCE THEORY AND MEASUREMENT TO STRUCTURAL VIBRATION Final Report, Jun. 1966–Aug. 1967**

Denis U. Noiseux and E. Bradley Meyer Wright-Patterson AFB, Ohio AF Flight Dyn. Lab. Aug. 1968 200 p refs (Contract AF 33(615)-5117)

(AD-676298; BBN-1562; AFFDL-TR-67-182) Avail: CFSTI CSCL 13/13

The mechanical impedance theory of vibration transmission is reviewed for deterministic and for random excitation. An approximate formulation for random vibration transmission is developed in terms of average admittances. It is applicable to frequency bands of random vibration like third octave bands. Mechanical admittances (driving point and transfer) are obtained experimentally for a rod and a beam and compared with calculations from the rod and beam equations with hysteretic damping. Elementary vibration transmission from a rod to a beam, and from a beam to a beam, are studied. Finally, random vibration transmission from a cylindrical shell to a black box is measured and compared with the results obtained from measured mechanical admittances. The agreement is fair. Approximations are emphasized. Author (TAB)

**N69-13441*#** Texas A&M Univ., College Station. Engineering Experiment Station.

**LINEAR AND NONLINEAR ANALYSIS OF SHELLS OF REVOLUTION WITH ASYMMETRICAL STIFFNESS PROPERTIES USER'S MANUAL**

J. C. de Andrade and J. A. Stricklin Oct. 1968 284 p refs (Grant NGL-44-001-044)

(NASA-CR-98519; Rept-68-65) Avail: CFSTI CSCL 20K

Two computer programs have been developed to perform a linear and nonlinear elastic analysis of shells of revolution under arbitrary loading with asymmetrical stiffness properties in the circumferential direction as well as variable thickness properties in the meridional direction. The method of analysis is the matrix displacement method of structural analysis. Input data define the elastic and geometric properties of the elements, the coordinates and constraints of the nodes, and the direction, magnitude and location of the loads. Output data consist mainly of the displacements of the nodes and the strains and stress resultants at the center of each element. The general purpose of this report is to provide a guideline for the preparation of input data for the computer codes. Author

**N69-13499#** Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.

**NONLINEAR OSCILLATIONS OF ELASTIC PANELS IN A SUPERSONIC NONVISCOUS AIRSTREAM**

Franklin E. Eastep Aug. 1968 128 p refs (Contract F44620-68-C-0036)

(AD-676682; SUDAAR-354; AFOSR-68-1861) Avail: CFSTI CSCL 13/13

A variational analysis is presented for the problem of a panel under the influence of both random excitation (turbulent boundary layer) and aerodynamic loading. Geometric nonlinear effects in the panel are taken into account, and a (Rayleigh–Ritz) modal approximation is used to represent the spatial variation of the displacements. The supercritical (beyond linear flutter boundaries) limit-cycle amplitude and frequency are determined by assuming a

fourier-series representation for the modal amplitudes, thereby reducing the problem to solving a set of nonlinear algebraic equations. The aerodynamic loads resulting from the panel deformation are approximated by linear piston theory. Random excitation in the form of a pressure with known spatial and temporal correlations is then introduced. The forced response is calculated with the aid of fourier-transform techniques and a method of equivalent linearization at flow conditions below and above the stability boundary for classical panel flutter. The effect of random excitation on the supercritical response is reduced to a study of coupled nonhomogeneous Mathieu equations. The solution of these equations is determined approximately using the digital computer. The determination of the amplitude of response and the frequency of oscillation provides the necessary information for a fatigue analysis.
Author (TAB)

**N69-13542#** Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
**STRUCTURAL INSTABILITY Final Report**
Wilfred H. Horton (Ga. Inst. of Tech.) and Stanley C. Bailey (Ga. Inst. of Tech.) Jun. 1968 175 p refs Prepared in Cooperation with Ga. Inst. of Tech.
(Contracts AF 49(638)-1495; DA-44-177-AMC-115(T); DA-44-177-AMC-258; DAAJ02-67-C-0031)
(AD-676282; AFOSR-68-1194) Avail: CFSTI CSCL 13/13

A brief discussion and visual representation of the instability modes for a wide range of practical bodies is presented and the correlation between theoretical predictions and experimental behavior is examined. The brief resume shows that, generally speaking, our knowledge with regard to the behavior of column and plate-type structures is based upon sound considerations. However, our understanding of the discrepancies between realized and predicted behavior for circular cylindrical shells under axial compression and spherical shells under external pressure loading is less than satisfactory.
Author (TAB)

**N69-13547#** College of Aeronautics, Cranfield (England). Dept. of Materials.
**THE USE OF A SIMPLE COMPOSITE ELEMENT TO DESCRIBE THE CREEP PROPERTIES OF FIBRE REINFORCED COMPOSITES**
M. Dootson Aug. 1968 20 p refs
(COA-Note-MAT-23) Avail: CFSTI

The stress-strain relationship for a composite material is dependent on both the geometry and the stress-strain relationships of the component phases. This note describes a technique by which the stress-strain relationship can be calculated for any fiber reinforced composite where the matrix has linear viscoelastic properties and the fibers are linearly elastic. The distribution of fibers within the composite is assumed to be macroscopically homogeneous but the distribution of fiber orientation can take any configurations. The problem is solved initially for the case where both phases are linearly elastic. A simple composite element from which a composite can be built up is defined and the stress-strain relationship for this element is calculated using variational methods. By summing these elements assuming either uniform stress or uniform strain throughout the composite, upper and lower bounds to the stiffness matrix of the composite are obtained. Using the correspondence principle these bounds for the purely elastic case are transformed to give the bounds for the viscoelastic case. The theoretical answers obtained using this method are compared with those obtained using a more simple model for the mode of combination of the two phases.
Author

**N69-13668#** United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
**CONTRIBUTION TO THE THEORY OF DEFORMATION AND FRACTURE**
J. H. Gittus 1968 38 p refs
(TRG-1293) Avail: Issuing Activity

A theory of deformation and fracture for metals under monotonic and cyclic stresses is developed from an analysis of line- and point-defect movements. The mean velocity of dislocations in a statistical assembly is first computed and used to define the stress and temperature dependence of steady-state creep rate. Then the time and strain dependence of dislocation density is derived leading to an expression for transient creep. Confirmatory data on dislocation density, creep and stress-strain are cited. Fracture by the nucleation and growth of grain-boundary voids or by crack propagation is analyzed. The probability of failure in stress rupture, owing to temperature, stress, pressure, grain size, and neutron irradiation are deduced and compared with experiments. A general fatigue law relating the probability of survival with a (complex) history of stress changes is developed and suitably simplified versions are verified with experimental data.
Author (NSA)

**N69-13669*** Texas A&M Univ., College Station.
**A RAPIDLY CONVERGING TRIANGULAR PLATE ELEMENT**
James A. Stricklin, Walter E. Haisler, Patrick R. Tisdale, and Richard Gunderson [1968] 8 p refs
(Grant NGL-44-001-044)
(NASA-CR-98575) Avail: CFSTI CSCL 20K

A compatible triangular plate element is presented, based on a complete third order polynomial for the normal displacement and second order polynomials for the inplane displacements. A nine degree of freedom element is obtained by requiring the transverse shear deformations to be zero at the nodes and along the sides of the element.
Author

**N69-13677#** Ohio River Div. Labs., Cincinnati.
**STUDY OF BENDING OF HIGH STRENGTH REINFORCING BARS**
I. Narrow Oct. 1968 26 p refs
(AD-676841; TR-2-73) Avail: CFSTI CSCL 13/13

The report presents the results of a review of bending requirements for concrete reinforcing steel and a survey of Corps of Engineers projects to determine the nature and extent of bending failures during field fabrication of nigh strength reinforcing bars. Although use of high strength reinforcing steel is increasing rapidly very few bending studies of steel bars have been made, and standard bending details are essentially the same as for milder grades of steel. The field bending experience at Corps of Engineers projects has been satisfactory, and few failures have occurred when standard bending practices have been followed. Failures have occurred when bending radii were less than standard and when straightening and rebending of bars was required. The general indication is that current standard detailing practices provide satisfactory limits for bending of all grades of reinforcing steel.
Author (TAB)

**N69-13696#** College of Aeronautics, Cranfield (England). Dept. of Materials.
**THE PRESSURE DISTRIBUTION OVER THE FLAT END SURFACES OF COMPRESSED SOLID RUBBER CYLINDERS**
M. M. Hall Jul. 1968 16 p refs
(CoA-NOTE-MAT-21) Avail: CFSTI

The shape of the pressure distributions over the flat end surfaces of compressed solid rubber cylinders was determined. The cylinders were compressed between metal end plates. The pressure distribution for compressive strains of less than 3% was approximately parabolic and was unaffected by the strains set up in the rubber due to the differential thermal contraction of the rubber and bonded metal end plates. A method of extending these measurements to large compressive strains, and a possible future program of work, is outlined.
Author

N69-13700# Israel Inst. of Tech., Haifa. Dept. of Mechanics.
**FREE EDGE BUCKLING OF HETEROGENEOUS CYLINDRICAL SHELLS IN AXIAL COMPRESSION**
Y. Stavsky and S. Friedland Feb. 1968 20 p refs Supported by Gerard Swope Found. and Technion Res. and Develop. Found.
(TDM-68-4) Avail: CFSTI

The resulting stability condition is shown to depend on the roots of the characteristic equation in such a way that only their *elementary symmetric polynomials* appear. Consequently, the stability condition is directly expressed in terms of the coefficients of the characteristic equation which need not be solved. It is shown that $\rho$, which the ratio between the free edge buckling force and the critical axial compression for a simply supported shell, strongly depends on a certain elastic parameter, expressing the effect of shell heterogeneity on its stability. If for a homogeneous isotropic shell $\rho$ is one half, for a composite shell it can vary, theoretically, between zero and one. Numerical results indicate that for a specific circular cylindrical shell composed of two orthotropic layers $\rho$ is 0.16; however when the location of these layers is reversed $\rho$ goes up to 0.84. Author

N69-13732# Notre Dame Univ., Ind. Coll. of Engineering.
**THE APPLICATION OF DYNAMIC RELAXATION TO THE FINITE ELEMENT METHOD OF STRUCTURAL ANALYSIS**
Robert D. Lynch, Sydney Kelsey, and Harry C. Saxe 25 Sep. 1968 124 p refs
(Contract N00014-68-A-0152; Proj. Themis)
(AD-676566; Themis-UND-68-1) Avail: CFSTI CSCL 13/13

The report is a study in depth of the method of Dynamic Relaxation, a matrix iterative method for the solution of simultaneous linear equations, and used principally in problems of structural analysis under static stress conditions. Whereas earlier investigators have restricted themselves almost exclusively to the finite difference formulation in space of both the equations of motion and the constitutive relationships, the present study formulates an alternative approach using finite elements in space. The mathematical basis for the finite element approach in space is developed, and followed by an analysis of convergence based upon a transformation into a standard eigenvalue problem for the error vector, intimately associated with the conditioning of the equations. Optimum convergence is studied and comparisons made with other iterative methods. Dynamic Relaxation is demonstrated by applying it to plane stress problems of statically loaded plates having discontinuities in the form of circular, elliptical and filleted square holes. Author (TAB)

N69-13769# California Univ., San Diego. Dept. of the Aerospace and Mechanical Engineering Sciences.
**ELASTIC-PLASTIC WAVE GENERATION BY IMPULSIVE ELECTROMAGNETIC RADIATION**
L. W. Morland Sep. 1968 35 p refs
Contract N00014-67-A-0109)
(AD-676324; TR-23) Avail: CFSTI CSCL 20/13

Absorption of radiation through a thin layer adjacent to irradiated, stress-free, surface causes rapid heating and the generation of stress waves. Temperature rises sufficient to cause plastic yielding are considered, and a resulting elastic-plastic wave solution is constructed. Comparison is made with the purely elastic solution, and in particular the reduced amplitude and pulse spread of the outgoing tensile wave is illustrated. Author (TAB)

N69-13785# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
**EMPIRICAL METHOD FOR CALCULATING PIPE INTERSECTIONS CONTAINING FISSILE SOLUTIONS**
Bruce B. Ernst and C. L. Schuske 9 Sep. 1968 16 p refs
(Contract AT(29-1)-1106)
(RFP-1197) Avail: CFSTI

An empirical method has been developed for calculating safe nuclear criticality parameters for complex arrays of intersecting cylinders (pipes or arms) containing enriched uranyl-nitrate solutions. The critical parameters defined by this method include cylinder diameters, angles of intersection, cylinder spacings, and the total number of intersecting cylinders involved in arrays. Discussed also are applications to typical problems encountered in fissile processing plants. Author (NSA)

N69-13807# Dayton Univ., Ohio. Research Inst.
**THE EFFECTS OF BUMPER MATERIAL PROPERTIES ON THE OPERATION OF SPACED HYPERVELOCITY PARTICLE SHIELDS**
Hallock F. Swift and Alan K. Hopkins (AFSC, Mater. Lab., Wright-Patterson AFB, Ohio) Wright-Patterson AFB, Ohio AFSC, Mater. Lab. Sep. 1968 53 p refs
(Contract F33615-68-C-1138)
(AD-676275; UDRI-TR-68-30; AFML-TR-68-257) Avail: CFSTI CSCL 22/2

An experimental study has been conducted to evaluate the importance of bumper materials selection upon the performance of two-component hypervelocity impact bumper shields. Several bumper materials were found that were equally effective on a mass per unit area basis. Bumper material effectiveness dropped rapidly with bumper material density when this density was below 2 gm/cc. Optimum bumper thicknesses exist for minimizing total shield weight for all bumper materials investigated. All of the data obtained in this study can be explained by an analysis of the states of the impacting pellet and bumper material within the debris cloud projected behind impacted bumpers. The most important parameter controlling shield operation is the state of the pellet material in the debris cloud. Author (TAB)

N69-13824# Illinois Univ., Urbana.
**EFFECT OF REPEATED LOADS ON THE LOW TEMPERATURE FRACTURE BEHAVIOR OF NOTCHED AND WELDED PLATES Final Report, Period Ending Oct. 1968**
W. H. Munse, J. P. Cannon, and J. F. Kiefner Washington Ship Struct. Comm. Oct. 1968 34 p refs
(Contract NObs-88283)
(AD-676722; SSC-188) Avail: CFSTI CSCL 13/5

The influence of repeated loadings on the susceptibility of weldments to fracture in a brittle manner is studied for an ABS-Class C steel. The test members have consisted primarily of 12, 24 and 36 in. wide notched-and-welded specimens that, at low temperatures, have been known to provide low-stress brittle fractures. Author (TAB)

N69-13828# Oak Ridge National Lab., Tenn.
**STRUCTURAL ANALYSIS OF THE BROOKHAVEN NATIONAL LABORATORY MOBILE GAMMA IRRADIATOR**
J. H. Evans Sep. 1968 62 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2178) Avail: CFSTI

The methods of evaluating the structural integrity of a container in which radioactive material is shipped to show compliance with the governing regulations are illustrated. The structural analysis performed on the Brookhaven National Laboratory Mobile Gamma Irradiator is described. Calculatory procedures and operating experience were applied in the analysis of the cask with respect to the regulations governing the general standards for packaging, the structural requirements, the normal conditions of transport, and the specified hypothetical accident conditions. Structural modifications were proposed to eliminate deficiencies in the existing cask, and this analysis demonstrated that with the proposed cask lifting devices, crash frame, and puncture apron, the irradiator complies with all the applicable regulations. Author (NSA)

**N69-13900#** Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
**SODIUM JACKET FOR TEMPERATURE EQUALIZATION**
Leo E. Chulos Sep. 1968 12 p
(Contract AT(45-1)-1830)
(BNWL-862) Avail: CFSTI

A sodium-filled furnace liner was designed and fabricated of commercially available stainless steel tubing selected to provide an annulus of 1/4 in. or larger, which was filled with sodium. The jacket was tested in a tube furnace. In using the sodium-filled jacket operator time was not required for equalizing the temperature along the gage section after the set-point temperature was reached. Measured temperature differences along the gage section were well within the ASTM recommended limits for creep testing. NSA

# 33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

**N69-12635** Illinois Univ., Urbana.
**ON HEAT TRANSFER WITHIN AND ACROSS NEARLY CIRCULAR CAVITIES INCLUDING THE EFFECTS OF VARIABLE WALL TEMPERATURE AND MASS BLEED**
Ervin Lynn Bales (Ph.D. Thesis) 1967 100 p
Avail: Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 68-1707

A mathematical model is developed describing the flow field and heat transfer inside and over a nearly circular cavity with arbitrary wall temperature distribution and including effects of mass bleed into the cavity core region at an arbitrary total temperature. The model was derived for steady, incompressible, constant property, turbulent flow over a two-dimensional cavity. A systems analysis delineated the individual parts of the complete flow field. The parts were then analyzed and interfaced to provide the complete cavity model. The dissipative aspects of the flow model established the velocity field on the basis of a mechanical energy balance. The general energy equation, with the aid of the now determined velocity field, was then used to calculate the convective heat transfer rates and establish a thermodynamic balance for the cavity. Dissert. Abstr.

**N69-12646** California Univ., Berkeley.
**THERMAL PULSING OF METALS UNDER HIGH PRESSURE**
Walter Alfred Stark (Ph.D. Thesis) 1967 128 p
Avail: Univ. Microfilms: HC $4.80/Microfilm $3.00 Order No. 68-165

Heat capacities of metals and semiconductors as functions of temperature and pressure in the Bridgman opposed anvil apparatus are described. The technique involves measurement of the rate of temperature increase in the sample as electrical energy is added at a known rate for a short period of time. The method was used to follow the heat capacity anomaly near the Curie temperature $T_c$ for gadolinium at pressures up to 20 kb. The heat capacity of iron was measured over the temperature range 150°-300°K for pressures between 20 and 100. A variation of the above technique using larger current pulses to thermally shock a metal under pressure has been applied to the high pressure transformations of bismuth, tin, and iron. This method appears to yield thermodynamic values of transition pressure. Finally, the dependence of the electrical resistance of iron on the three-halves power of the absolute temperature at pressures greater than 20 kb is noted. Dissert. Abstr.

**N69-12648** St. Louis Univ., Mo.
**THERMAL CONDUCTIVITIES OF SOME POLYATOMIC GASES AT MODERATELY HIGH TEMPERATURES**
Philip Goon Choy (Ph.D. Thesis) 1967 115 p
Avail: Univ. Microfilms: HC $5.60/Microfilm $3.00 Order No. 68-1214

The thermal conductivities of nitric and nitrous oxides, carbon tetrafluoride, silicon tetrafluoride, sulfur hexafluoride and boron trifluoride have been determined at moderately high temperatures, ranging from about 60°C to about 400°C. A thermal conductivity cell of the potential leads hot-wire type was used. The cell was contained in a specially constructed furnace, whose temperature was controlled to within 1°C. The cell was constructed from a Vycor tube, inside of which was stretched an axially oriented platinum heating wire. This heating wire was joined to thick tungsten wires which led to the external circuit. The experimental coefficients of thermal conductivity of the gases investigated are found to vary linearly with temperature for the range of temperatures used in this investigation. Boron trifluoride is an exception in that the variation is not linear beyond 350°C due to reaction with the silica of the wall of the conductivity cell. Dissert. Abstr.

**N69-12689#** Los Alamos Scientific Lab., N. Mex.
**THERMODYNAMIC PROPERTIES OF PuN BY GALVANOSTATIC POTENTIAL DETERMINATION**
George M. Campbell 16 Aug. 1968 9 p refs
(Contract W-7405-ENG-36)
(LA-3945) Avail: CFSTI

The emf of the cell $Pu(s,l)|PuCl_3$, $LiCl-KCl\,N_2(g)$, PuN(s) was determined over the temperature range 714° to 1032°K. By using a W microelectrode, the equilibrium potential of the Pu(s,l) electrode was determined by a galvanostatic technique, avoiding the complications rising from reaction of $N_2$ with Pu. Over this temperature range, at 1 atm $N_2$ the emf is $E = 7.90071 - 2.31690 \times 10^{-2} + 2.517855 \times 10^{-5}\,T^2 - 9.1644 \times 10^{-9}\,T^3$ (±0.003) volts. Above the melting point of Pu(913°K) the standard free energy of formation of PuN is $-\Delta G_f = 73.8 - 0.0225\,T$ kcal/mole PuN. From the condition $S_{298}$ (PuN) $- S_{298}(Pu) = S_{298}(UN) - S_{298}(U)$ the estimate $-\Delta H_{298} = 72.5$ kcal/mole is made. Author (NSA)

**N69-12739*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**DESIGN-POINT PERFORMANCE OF A DOUBLE CONTAINMENT TANTALUM AND STAINLESS STEEL MERCURY BOILER FOR SNAP-8**
James A. Albers, Ronald H. Soeder, and Pierre A. Thollot Washington Dec. 1968 56 p refs
(NASA-TN-D-4926) Avail: CFSTI CSCL 20M

Experimental data were obtained on the performance of a SNAP-8 tantalum and stainless-steel double-containment boiler. The boiler was a counterflow heat exchanger consisting of seven tubes coiled with a 2-1/2-turn helical shell. The experimental results are presented for a total operating time of 1445 hours. The range of mercury flow rates was from 7,500 to 11,800 lb mass/hr (3400 to 5350 kg/hr), and the primary NaK flow was varied from 29,000 to 49,000 lb mass/hr (13,000 to 22,200 kg/hr). The NaK temperature into the boiler was varied from 1272 to 1318°F (962 to 988°K). Author

**N69-12747** Stevens Inst. of Tech., Hoboken, N. J.
**THE HEAT EQUATION WITH TWO FREE BOUNDARIES**

Norma M. Gilbert (Ph.D. Thesis) 1967 29 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-1157

Stefan's problem with two free boundaries is discussed. The general case is reduced to a set of integral equations, and a constructive existence proof is given for a special case. Stefan's problem with one free boundary may be interpreted physically as the evaporation of a plane liquid in a gas which surmounts it: one wishes to determine the position of the surface-barrier and the rate of evaporation as functions of time. The mathematical problem to which this gives rise has been generalized to the case of two free boundaries. Theorem 1 is proved by using a Fourier integral transform, theorem 2 by finding upper and lower bounds of solutions among certain special classes of functions and setting up sequences which converge to solutions, and theorem 3 by proving that any continuously differentiable solutions belong to these special classes, and thus are identical with the solutions found in theorem 2. Dissert. Abstr.

**N69-12766** Brown Univ., Providence, R. I.
**SOME RESULTS IN CONTINUUM THERMODYNAMICS**
William Orville Williams (Ph.D. Thesis) 1967 51 p
Avail: Univ. Microfilms: HC $3.00/Microfilm $3.00 Order No. 68-1516

This dissertation consists of three completely self-contained parts. It is shown that restriction of the complete symmetry group of a material to density-preserving transformations, which is always assumed in the literature, is, under very general conditions, a consequence of the second law of thermodynamics. A method is described to characterizing phases of materials by specification of the symmetry group as a function of deformation and temperature. For an elastic material with phase determined by density and temperature it is shown that most of the usual results for the overall symmetry group are also true for the group corresponding to a given phase. A method of axiomatically deriving a form of the second law of thermodynamics appropriate to continuum physics from a general statement of the law is discussed; this logically leads to the existence of two temperatures and a modified form of the Clausius–Duhem inequality. Dissert. Abstr.

**N69-12770** Rensselaer Polytechnic Inst., Troy, N. Y.
**HEAT TRANSFER IN POROUS MEDIA CONTAINING A VOLATILE LIQUID**
Walter Herman Breyer (Ph.D. Thesis) 1967 102 p
Avail: Univ. Microfilms: HC $5.20/Microfilm $3.00 Order No. 68-814

An investigation has been made of heat transfer in porous media where a volatile liquid occupies a portion of the pore space. Particular consideration was given to the case of steady-state heat transfer in a closed system. An analysis of simultaneous heat and mass transfer in porous media was accomplished using nonequilibrium thermodynamics. This analysis goes beyond previously published analyses in that the driving forces that appear in it are specifically related to accessible experimental parameters. It is shown that for the case of steady-state heat transfer in a closed system where equilibrium exists between the liquid and vapor components this analysis reduced to Fourier's law. An experimental investigation of closed, unidirectional porous systems at a steady-state condition was accomplished and appeared to support the nonequilibrium thermodynamic analysis. Dissert. Abstr.

**N69-12849#** Reactor Centrum Nederland, Petten.
**SATAN 2: A PROGRAM FOR THE CALCULATION OF THERMAL GROUP CONSTANTS BY MEANS OF CONVERTING THE ENERGY AND SPACE DEPENDENT INTEGRAL TRANSPORT EQUATION INTO AN ENERGY DEPENDENT ONE**
A. Tas and A. W. den Houting Jan. 1968 131 p refs
(RCN-95) Avail: CFSTI

The SATAN-2 program for the calculation of thermal group constants by conversion of the energy- and space-dependent integral transport equation into an energy-dependent equation is described. The program is written in ALGOL 60 for the EL-X8 computer. The mathematical formulation of the program is presented; and flow charts, sample input, and alisting of the program are included. NSA

**N69-12862#** Argonne National Lab., Ill.
**SURFACE RENEWAL MODELS FOR HEAT TRANSFER BETWEEN WALLS AND FLUIDIZED BEDS**
R. D. Patel Nov. 1967 110 p refs
(Contract W-31-109-ENG-38)
(ANL-7353) Avail: CFSTI

Work was performed to develop a model to describe heat transfer from wall surfaces in a fluidized bed and to demonstrate the model's accuracy experimentally. Models previously presented are reviewed. The equipment and procedures used to measure heat-transfer coefficients and particle residence times at the identical wall surface under the same conditions are described. Heat transfer coefficients were measured for cellulose acetate, glass, copper, aluminum, and alumina in sizes ranging from 0.001 to 0.01 ft. Residence times were measured for only the glass and cellulose acetate. The residence times for other particles were obtained from a dimensionless correlation between residence time and gas velocity using the glass and acetate data. Air was used as the fluidizing gas. Two surface-renewal models are presented. Both gave predictions within an average 30% of the data for glass. For the other systems, the deviation was greater. NSA

**N69-12895#** Los Alamos Scientific Lab., N. Mex.
**SPACE ELECTRIC POWER R AND D PROGRAM, PART 1 Quarterly Status Report, Period Ending 31 Jul. 1968**
23 Aug. 1968 6 p ref
(Contract W-7405-ENG-36)
(LA-3986-MS-Pt-1) Avail: CFSTI

Heat transfer experiments with Na and K in annular return heat pipes have shown that large capillary forces can develop in such a pipe if a tube of five porosity separates the liquid return path from the vapor passage. The procedure for fabricating porous tubes from several layers of five-mesh screen is described. Methods for determining the pore size of the tubes and the capillary force that can develop in the finished product are discussed. NSA

**N69-12921** Tulane Univ., New Orleans.
**PROPERTIES OF FROST FORMING ON A COLD PLATE LOCATED IN STILL AIR**
James Colvin Mulligan (Ph.D. Thesis) 1967 107 p
Avail: Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-17934

An experimental investigation of the frost formation on a vertical flat plate when exposed to a humid environment has been performed. An environmental chamber was used to maintain quiescent air with a controlled relative humidity. A 1.5×6.0 foot vertical plate was used as a test surface with thermocouple probes for boundary layer and local frost temperature measurements. Heat flow meters were mounted at various positions along the plate for local heat flux measurements. Frost thickness measurements were made with a depth gauge and average density measurements obtained by coring. Experiments were made utilizing both liquid nitrogen as coolant and a mixture of dry ice and methanol. The average frost density was approximately 2.6 lb/ft$^3$. The insulating characteristic of the frost was found to reduce the initial heat flux by 40 to 50%. The variation of the log of the local Nusselt number

with the log of the Rayleigh number was found to be linear and to agree well with the variation in the absence of mass transfer. Dissert. Abstr.

N69-12962 Alabama Univ., University.
**A STUDY OF SURFACE-TO-BED HEAT TRANSFER IN A VIBRATED FLUIDIZED BED**
Vassiliki S. Lygeros (Ph.D. Thesis) 1967 176 p
Avail: Univ. Microfilms: HC $8.20/Microfilm $3.00 Order No. 68-1051

The effect of vibration on the heat performance of a fluidized bed has been studied by measuring heat transfer coefficients between an externally vibrated bed and an axial internal surface. The effect of vibration was found to depend on the velocity of the air used to fluidized the bed. Vibration caused a considerable increase in the heat transfer coefficient at air velocities near the minimum fluidizing velocity. A mathematical model describing heat transfer between the fluidized bed and the surface was derived. The residence time of particle packets on the surface was expressed as a function of bubble volume, number, and velocity and of particle diameter and density. This model was found to satisfactorily correlate the experimental data for an unvibrated bed obtained during the present investigation. Dissert. Abstr.

N69-13039# Geoscience, Ltd., Solana Beach, Calif.
**INVESTIGATION OF FUNDAMENTAL MECHANISMS AND PARAMETERS THAT INFLUENCE STEADY STATE AND TRANSIENT PERFORMANCE OF RANKINE CYCLE LIQUID METAL SYSTEMS Annual Report, Jul. 1, 1967–Jun. 30, 1968**
H. F. Poppendiek, N. D. Greene, W. B. Goddard, and C. M. Sabin
Jun. 1968 72 p refs
(Contract AT(04-3)-677)
(GLR-64; SAN-677-29) Avail: CFSTI

A program was undertaken to determine the phase distribution in an actual liquid metal boiler by direct observation. The experimental work included construction of a transparent observation section or port in a boiler tube, development of microscopic photography techniques, and the photographing of phase distributions in air-mercury, boiling Freon, and boiling mercury in forced, convective, two-phase flow under linear and helical flow conditions. The equipment and procedures are described in detail. Results of the boiling mercury phase distribution experiments are presented. These include photographic phase distribution data obtained at known vapor qualities with both heated and non-heated observation ports during linear and helical boiling mercury flow, heat transfer conductance measurements, mercury vapor quality determinations, and their interrelationships. NSA

N69-13058# General Electric Co., Cincinnati, Ohio. Missile and Space Div.
**A BRIEF GUIDE TO THE USE OF VERSION E OF THE TRANSIENT HEAT TRANSFER COMPUTER PROGRAMS (NMP-857)**
S. C. Skirvin 6 Jun. 1968 41 p refs
(GEMP-614) Avail: CFSTI

Instructions are presented for use of Version E of the Transient Heat Transfer computer programs (THTE). These instructions are minimal in the sense that they are not self contained, but supplement the THTD User's Manual. THTE computes transient and steady state temperature distributions in large generalized three-dimensional systems, but is faster and potentially more accurate than THTD. In addition, THTE computes flow and pressure drop for one dimensional, single phase gases and liquids on a steady-state or pseudo transient basis. THTE has not been fully implemented and has received only limited production use. The status of checkout is indicated. Author (NSA)

N69-13142 South Carolina Univ., Columbia.
**LINEAR ANALYSIS OF THERMAL RADIANT ENCLOSURE**
Shih-lu Chang (Ph.D. Thesis) 1967 96 p
Avail: Univ. Microfilms: HC $5.00/Microfilm $3.00 Order No. 67-15563

Linear graphs are used to provide a means of determining a model for thermal radiant enclosure, which will be useful either in analysis or in calculation, especially for a systematic treatment of large enclosures with complicated geometry. A matrix inverting method is introduced not only to simplify the calculating procedure, but also to interpret the multi-reflection and re-emission effects. The simplest linear graph model for thermal radiant enclosure is applied to the restricted case of gray enclosure containing non-absorbing media. Then it is shown how the more complex situation can be reduced to this same simple model rather than constructing additional complicated models. Dissert. Abstr.

N69-13164 Cincinnati Univ., Ohio.
**A THEORY OF THE HEAT CAPACITY IN THE CRITICAL REGION**
David Neal Boehnke (Ph.D. Thesis) 1967 110 p
Avail: Univ. Microfilms: HC $5.40/Microfilm $3.00 Order No. 67-15950

Statisticomechanical considerations based on the contribution to the excess heat capacity by "adsorptive clustering" near the critical temperature lead to two expressions, each in very good agreement with experimental data on several one-component and one two-component systems. The Debye length for argon and for the cyclohexane-aniline binary liquid system in particular are predicted in good approximation. The development relies upon an heuristically conceived relation between the entropy and the number of molecules adsorbed upon the surface of a "cluster" in the immediate neighborhood of the critical temperature, but slightly above it. Lambda behavior is correlated. Dissert. Abstr.

N69-13231*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**EFFECTS OF STEADY-STATE ACCELERATION ON COMBUSTION CHARACTERISTICS OF AN ALUMINIZED COMPOSITE SOLID PROPELLANT**
G. Burton Northam Washington Dec. 1968 43 p refs
(NASA-TN-D-4914) Avail: CFSTI CSCL 21I

The objective was to determine the effect of acceleration level, and acceleration field orientation on the combustion of aluminized composite solid propellant. Unidirectional burning slab motors were fired on a ballistics centrifuge at acceleration levels from 0g to 300g. Tests were conducted with the acceleration loads directed normal into the burning surface, normal out of the burning surface, and at orientations of 0°, 30°, 60°, and 75° into the burning surface. The resulting surface condition of the propellant was examined under the various test conditions by extinguishing a limited number of propellant samples. As the normal acceleration load into the burning surface increased, the average propellant burning rate, the pitting of the propellant surface, and the amount of metallic-like residue retained within the test motor increased. At orientations other than normal and into the burning surface, neither the burning rate, the pitting, nor the metallic-like residue were much increased at acceleration levels as high as 300g. At an average chamber pressure of 500 psia (3.45 MN/m$^2$) the propellant burning rate increased approximately 21 percent as the normal acceleration level was raised from 0g to 300g. Author

N69-13305# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CONVECTIVE HEAT EXCHANGE IN A TUBE WITH PULSATIONS OF THE GASEOUS HEAT CARRIER WITH A**

**FREQUENCY CORRESPONDING TO THE SECOND RESONANCE HARMONIC**

B. M. Galitseyskiy et al *In its* Nuclear Reactor and Heat Exchanger Thermal Dynamics 14 Aug. 1967 p 13–32 refs (See N69-13305 03-22)
Avail: CFSTI

The paper presents the influence of velocity (or pressure) pulsations on heat transfer at high frequencies, when the influence of the pulsations of the local heat transfer coefficient is expected to be due essentially to changes in the distribution of the turbulent conductivity along the radius in a given section of the channel. The tests were made in an acoustically closed tube at a frequency corresponding to the second resonant harmonic, when a complete standing wave subtended the length of the tube. A criterial relation is derived for the relative heat transfer in such a case in terms of the Nusselt, Reynolds, and Prandtl numbers and the flow parameters. The tests were made with air in a specially calibrated stainless steel tube heated with low voltage alternating current.
Author

**N69-13316#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**CERTAIN PROBLEMS OF HEAT-ENGINEERING IN EQUIPMENT FOR OPEN CYCLE MPD GENERATORS [NEKOTORYYE IZ PROBLEM TEPLOTEKHNICHESKIKH USTANOVOK DLYA OTKRYTYKH TSIKLOV MPD GENERATOROV]**

Jiri Schneller et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 11–25 refs (See N69-13314 03-03)
(SM-74/82) Avail: CFSTI

High temperature combustion chambers and heat exchangers are the critical parts of open cycle MPD generators. Studies were conducted to judge the performance of combustion chambers and heat exchangers, with a view towards their possible technical use in continuous and economical operation. In combustion chambers for liquid fuel, high temperatures attained depend on properties of the construction material utilized, on the degree of preheating of the air for combustion and on the method of cooling the walls. Some principles of intense cooling of walls (convectional, film, porous) are known, but in view of the required mode of operation and continuous service, their application is, to a large extent, limited by the degree of technical perfection required for their construction. One of the possible economical methods of cooling the walls is to use the air directly for combustion in order to provide convectional cooling of the active parts of the chamber. This method, even though it does not provide very intense cooling, has certain advantages. The heat removed by the cooling is immediately restored to the process so that the equipment has a relatively high thermal feasibility.
Author

**N69-13334#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**COMPOSITION AND THERMODYNAMIC PROPERTIES OF THE COMBUSTION PRODUCTS OF NATURAL FUELS WITH IONIZING ADDITIVES [SOSTAV I PERMODINAMICHESKIYE SVOISTVA PRODUKTOV SGORANIYA PRIRODNYKH TOPLIV S IONIZIRUYUSHCHIMI DOBAVKAMI]**

V. C. Yungman et al *In its* Intern. Symp. on Production of Elec. Power by Means of MHD Generators 14 Nov. 1968 p 221–232 refs (See N69-13314 03-03)
(SM-74/217) Avail: CFSTI

For the construction and operation of magnetohydrodynamic converters of thermal energy into electrical energy, operating on natural fuel, it is necessary to have information about the equilibrium composition and the thermodynamic properties of the combustion products of natural fuels with ionizing additives. Pertinent computations were carried out for the combustion of methane in air and in air–oxygen mixture for a wide range of temperatures and pressures and for different proportions of the fuel and the oxident, both with and without ionizing additive. The results of these computations, in the form of i–s diagrams and tables of the equilibrium composition, are mentioned.
Author

**N69-13351#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**AN INVESTIGATION OF IONIZATION AND CONDUCTIVITY OF COMBUSTION PRODUCTS IN THE PRESENCE OF SOLID PARTICLES WITH A SMALL ELECTRON WORK FUNCTION [ISSLEDOVANIYE IONIZATSII I PROVODIMOSTI PRODUKTOV SGORANIYA PRI NALICHII TVERDYKH CHASTITS S MALOY RABOTOY VYKHODA ELEKTRONOV]**

E. P. Zimin et al *In its* Intern. Symp. on Production of Elec. Power by means of MHD Generators 14 Nov. 1968 p 405–418 refs (See N69-13314 03-03)
(SM-74/243) Avail: CFSTI

A method of increasing the conductivity of a gas without increasing its temperature is being studied. This method is based on the use of small solid particles of a material which is characterized by a small electron work function. The idea of increasing the conductivity by such a method was suggested by experimental observations of high electron concentrations in carbon flames. It was assumed that the ionization in this case is determined mainly by the thermionic emission of electrons from carbon dust particles which are formed in high grade flames and are characterized by a mean radius of $\approx 10^{-6}$ cm and a work function of 4.35 ev. There is a real possibility of increasing the electron concentration in a gas by introducing finely dispersed dusts of a material with a small work function. Experimental data is presented on the conductivity of a gas seeded with dust. At temperatures of 2200°, 2400°, and 2530°K, the dependence of the conductivity of the combustion products of the natural gas on the percentage content of the induced particles of barium oxide and calcium oxide was obtained experimentally.
Author

**N69-13356#** Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires.

**HEATING OF LEAD CASKS. AN ANALYTICAL SOLUTION TO THE HEAT EQUATION MADE UP OF A SERIES OF LAGUERRE FUNCTIONS [ECHAUFFEMENT DES CHATEAUX DE PLOMB. UNE SOLUTION ANALYTIQUE A L'EQUATION DE LA CHALEUR CONSTITUEE PAR UNE SERIE DE FONCTIONS DE LAGUERRE]**

Philippe Formery and Andre Giles Mar. 1968 28 p in FRENCH
(CEA-R-3373) Avail: CFSTI

The packing used for the transport of highly radioactive materials such as in-pile irradiated rods must comply with fairly strict safety standards. They should be particularly resistant to fire without the radioactive protection being seriously affected. The heating of a transport cask placed in a fire has been calculated by normal automatic computation methods assuming that only thermal radiation is responsible for the heating and that this obeys Stefan's law. Simultaneously, a purely analytical treatment has been attempted. The existence of a simple solution, of the Laguerre function type, to the heat equation has been demonstrated. By superimposing an infinite number of simple solutions, it is possible to produce a fairly general solution, depending on parameters, which satisfies the initial state and the limiting conditions. The parameters can be adjusted so that the temperature and flux produced on the shell by this solution approximately satisfy Stefan's relationship.
Author (NSA)

**N69-13380#** Bureau of Mines, Washington, D. C.
**EXPLOSIBILITY OF MISCELLANEOUS DUSTS**
John Nagy, Austin R. Cooper, and Henry G. Dorsett, Jr. Dec. 1968 35 p
(BM-RI-7208) Avail: CFSTI

Dust explosion data obtained in laboratory tests are presented for 181 miscellaneous materials that present an explosion hazard. Data are given also for 50 dusts that present primarily a fire hazard and for 88 dusts that did not present an explosion hazard. Author

**N69-13372#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**A PYROTECHNIC-ACTIVATED CALORIMETER FOR FLIGHT RESEARCH AT LUNAR RETURN VELOCITY**
Don. D. Davis and Clotaire Wood 1968 16 p Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
(NASA-TM-X-61403) Avail: CFSTI CSCL 22C

The ignition device of a heat shield ejection system designed to study reentry heat problems associated with NASA Project Fire is described and its characteristics are discussed. Both qualification testing and development testing results are given. ESRO

**N69-13377#** Imperial Chemical Industries, Ltd., Stevenson (Scotland).
**CRITERIA GOVERNING THE DESIGN OF ELECTRO-EXPLOSIVE DEVICES FOR EXTREME CONDITIONS**
L. E. Medlock [1968] 6 p ref Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

Single-shot devices cannot be tested for functioning ability and the 99.99% reliability required for electro-explosive devices (EED) requires a go-no go testing of very large numbers of devices and the improvement of design criteria. The igniter and the delay systems of an EED are analyzed with a view to improving their design and gaining the required reliability. ESRO

**N69-13378#** Stanford Research Inst., Menlo Park, Calif.
**BASIC STUDIES OF THE MECHANISM OF SHOCK INITIATION IN GRANULAR EXPLOSIVES**
Leslie B. Seely and Marjorie Evans [1968] 17 p Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968 Sponsored in part by U.S. AFOSR
Avail: CFSTI

The shock sensitivity of granular low density explosives under conditions emphasizing the effect of heterogeneity is considered. Experiments carried out on ammonium perchlorate and relevant experimental devices are described. Other experiments confirmed the positive slope region of the Hugoniot equation by extending the pressures to lower values and by generating the equation for the solid crystal for comparison. Low pressure shocks were generated with a light gas gun to eliminate systematic experimental errors and the general nature of the curves was confirmed. Similar experiments with potassium chloride are also described. It is concluded that the locus for shocked states in ammonium perchlorate is the result of chemical reaction in the material during its compression. The relationship of hot spots to hydrodynamics, the evidence for surface burning and the vulnerability to external shock are also discussed. ESRO

**N69-13379#** Naval Postgraduate School, Monterey, Calif.
**CHARACTERISTICS OF IGNITER FORMULATIONS**
E. Sinclair [1968] 10 p Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

Fuels and oxidizers that can be used to prepare igniters are reviewed and their characteristics are discussed. The oxygen balance method is useful for considering the initial mixing of compounds but the mixture must then be analyzed experimentally and some instruments are described. ESRO

**N69-13395#** Etablissement d'Etudes et de Fabrications d'Armement, Bourges (France). Direction Technique d'Armements Terrestres.
**STAGE SEPARATION USING EXPLOSIVE CORDS [LE DECOUPAGE INTER-ETAGE PAR CORDEAUX DETONANTS]**
Bernard Ceyrat and Heliane Carabin 1968 29 p In FRENCH Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

Stage separation can be carried out by using blasting cord with a particular transverse section and its use in different systems, e.g. detonators, relays, caps and primacord are described. The pyrotechnic chain from the initiation to the propagation of the blast is discussed and illustrated with a practical example. ESRO

**N69-13403#** Atelier de Construction de Tarbes (France). Direction Technique des Armements Terrestres.
**THE EXPLOSIVE CHARACTERISTICS OF PRIMING EXPLOSIVES [LES CARACTERISTIQUES EXPLOSIVES DES EXPLOSIFS D'AMORCAGE]**
M. Lenotre [1968] 20 p In FRENCH Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

Test methods and equipment for the determination of the properties of priming explosives are described and shock sensitivity and performance tests on some samples are reported. The characteristics of nitrides, dinitrobenzofurazanylate, azotetrazoles and other explosive materials are listed. ESRO

**N69-13404#** British Aircraft Corp., Filton (England).
**THE SCIENTIFIC AND ENGINEERING APPLICATIONS OF PYROTECHNICS IN THE SKYLARK SOUNDING ROCKET**
G. G. E. Lewis Jun. 1968 11 p Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

The pyrotechnic devices and techniques employed in the Skylark rocket for scientific and engineering purposes are discussed. ESRO

**N69-13418#** General Precision, Inc., Sunnyvale, Calif.
**DESIGNING ELECTRO-EXPLOSIVE DEVICES FOR SPACE**
D. E. Davenport, L. D. Pitts, and H. D. Peckham (Gavilan Coll.) 1968 46 p Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

Electro-explosive devices (EED) for space applications are discussed and a theory of the initiation phenomena, based on the thermal transfer in the neighborhood of the bridgewire, is developed which enables one to predict in a quantitative way the effect of several design parameters on the no-fire and all-fire levels of a device. Electrostatic safety design is considered and the characteristics and behavior of single dielectrics, including explosives, and the behavior of series and parallel dielectrics are discussed. ESRO

**N69-13443#**
**ON THE THEORY OF HEATING AT HYPERSONIC FLOW**
L. M. Biberman and S. Ia. Bronin [1968] 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 182, no. 2, 1968 p 522–525
Avail: CFSTI

Supersonic air flow around a blunt body is examined in the neighborhood of the stagnation point. Viscosity, heat conduction, radiation energy transfer, and air spectrum are taken into account; thermodynamic equilibrium is assumed. A system of equations was derived and transformed to evaluate the divergence in radiant energy flux density. The magnitude of the shock wave standoff, the velocity, temperature and pressure profiles in the compressed layer, and the convective and radiative heating components were determined. Analysis of results showed that radiation transfer did not change the pressure in the compressed layer, however it decreased the temperature, and increased the density. Cooling of the compressed layer resulted in a reduction in the convective heating component. B.P.

**N69-13449#** Space Ordnance Systems, Inc., El Segundo, Calif.
**THE DEVELOPMENT OF A NON-CONDUCTIVE IGNITION COMPOSITION FOR RFI PROTECTION OF SPACECRAFT ELECTRO-EXPLOSIVE DEVICES**
John T. Greenslade [1968] 13 p refs Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

A method of protecting electro-explosive devices against premature ignition by RFI in a spacecraft environment is considered. It consists of substituting a relatively non-conductive (NC) ignition composition for the conventional primary ignition material in contact with the EED bridgewire(s). Some details of a specific NC composition which was successfully tested in modified Apollo Standard Initiators are given. Author (ESRO)

**N69-13472#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**POLYEMPIRICAL THEORY OF HEAT EXCHANGE OF A THIN PLATE AROUND WHICH FLOWS A RAREFIED GAS AT HIGH MACH NUMBER [POLUEMPRICHESKAYA TEORIYA TEPLOOBMENA TONKOI PLASTINY, OBTEKAEMOI RAZREZHENNYM GAZOM, PRI BOLSHIKH CHISLAKH MAKHA]**
Yu. A. Koshmarov Sep. 1967 17 p refs Transl. into ENGLISH from Teplo-Massoperenos (USSR), v. 2, 1965 p 157–169
(AD-676567; FTD-HT-23-532-67) Avail: CFSTI CSCL 20/4

The problem of heat transfer to an infinite cooled flat plate in hypersonic rarefied gas flows at zero angle of attack is considered. A theoretical analysis of a flow model and heat transfer is developed on the basis of the results of a series of experimental investigations, assuming that the plate thickness is very small as compared with the mean free path of molecules in a free flow, the values of the interaction parameter are rather high, and the surface temperature is constant everywhere. The boundaries between single collisions and transition zones are approximately established and the effect of rarefaction on their relative importance is considered. Author (TAB)

**N69-13478#** Michigan Univ., Ann Arbor. Fluid Dynamics Lab.
**COMBUSTION KINETICS OF TETRAFLUOROETHYLENE Final Technical Report**
Richard A. Matula Jul. 1968 49 p refs
(Grant AF-AFOSR-1144-67)
(AD-676680; AFOSR-68-2134) Avail: CFSTI CSCL 21/2

The pyrolysis of C2F4, C3F6, and CF2O were studied in the temperature and pressure ranges 300-455C, 25-760 torr; 550-675C, 50-410 torr; and 330-480C, 25-800 torr, respectively. The rate equations and appropriate Arrhenius rate constants for these three reactions are reported. The oxidation kinetics of C2F4 are also being investigated and preliminary results in the temperature and pressure ranges 175-300C and 25-200 torr are discussed. Finally the application of gas-solid chromatography techniques to the separation of low molecular weight fluorocarbons and the analysis of the C2F4 oxidation products are discussed. Author (TAB)

**N69-13509#** Atelier de Construction, Tarbes (France). Direction Technique des Armements Terrestres.
**IGNITION OF PRIMING EXPLOSIVES BY MEANS OF ELECTRONS AND PHOTONS [INITIATION DES EXPLOSIFS D'AMORCAGE PAR ELECTRONS ET PAR PHOTONS]**
L. d'Ast [1968] 18 p refs In FRENCH Presented at the CNES Intern. Colloq. on Util. of Pyrotech. and Explosive Elem. in Space Designs, Tarbes, France, 9–12 Jul. 1968
Avail: CFSTI

Priming explosives can be ignited by the action of many different energy sources and experiments on the ignition of lead and cadmium oxides by means of electric discharges using both fixed and moving electrodes are described. The behavior of explosives under a laser beam is also studied and other means of ignition (e.g. electrons, photons) are discussed. ESRO

**N69-13555#** Atlantic Research Corp., Alexandria, Va. Kinetics and Combustion Group.
**A STUDY OF THE EXPLOSION LIMITS OF SIMPLE DIFLUORAMINO COMPOUNDS Semiannual Progress Report, Feb. 1–Jul. 31, 1968**
Guenther von Elbe, J. B. Levy, and G. White Oct. 1968 32 p ref
(Contract Nonr-4065(00))
(AD-676512; SAPR-5) Avail: CFSTI CSCL 21/9,1

The fluorine-induced explosions of IBA, 1,2-DB, 2,3-Db and M-2,3-DB were studied by admitting measured amounts of F2 to the vapors of these compounds. Whereas very small amounts of F2 are required to produce explosions with IBA, 1,2-DB and 2,3-DB, substantial amounts of F2 were required to produce an observable luminous flash with M-2,3-DB. Samples of IBA and 1,3-DP were decomposed to completion with F2 and the decomposition products analyzed by mass spectroscopy. The resulting data is used to propose a reaction scheme. Data was obtained on thermally induced explosions of 1,2-DB and 2,3-DB. Analogous to the explosion mechanism for 1,3-DP chain branching occurs by decomposition of free DB radicals to yield F and NF radicals, and chains are broken by diffusion of DB radicals to the vessel surface. Author (TAB)

**N69-13572#** IIT Research Inst., Chicago, Ill.
**ION MOLECULE REACTIONS IN FLAMES Final Scientific Report**
Paul Feng Sep. 1968 60 p
(Contract AF 49(638)-1573)
(AD-676698; IITRI-U6023-1; AFOSR-68-1923) Avail: CFSTI CSCL 21/2

Studies of charge recombination and equilibrium were carried out in a number of hydrogen-oxygen flames containing selected additives including CH4, C2H6, C3H8, C4H10, CF4, CF3Cl, and C4F10. Analysis of the experimental data on the basis of the theory of ionization chambers show that (1) although free electrons do constitute the most important negatively charged species, a considerable amount of heavier negative ions do exist in the flames studied in this program as the result of electron capture by oxygen or other molecular species; and (2) charge neutralization occurs to an appreciable extent even in the presence of external electric

fields capable of collecting apparent saturation currents. In addition, the fact that the introduction of even non-combustible additives such as CF4 could result in increased ion currents (apparently due to chemi-ionization processes involving excited carbonaceous intermediates) suggests that this phenomenon could well be used for the analysis of such compounds by flame ionization methods. Author (TAB)

**N69-13665#** California Univ., Berkeley. Lawrence Radiation Lab.
**THE THERMODYNAMIC PROPERTIES OF $He^4$ NEAR THE MELTING LINE**
James Karl Hoffer (Ph.D. Thesis) Jul. 1968 231 p refs
(Contract W-7405-ENG-48)
(UCRL-18319) Avail: CFSTI

Constant volume heat capacity measurements have been made on $^4He$ covering the entire volume range of the bcc solid phase and the high-volume portion of the hcp phase. The $C_v$ measurements extend to low-enough temperatures to determine the entropy accurately and the direct volume measurements were sufficiently precise to establish the V–T phase diagram. The entropy–volume relations in the various two-phase mixtures were then used to calculate the P–T phase diagram. The hcp–bcc solid–solid transition was found to have a more regular behavior than previous direct PVT data would suggest. Combined with data recently obtained in this laboratory on the superfluid liquid phase the low-temperature P–T and V–T melting lines were accurately determined, yielding quantitatively the minimum in the P–T curve at 0.776°K and the maxima in the V–T freezing and melting curves at 0.801 and 0.886°K, respectively. No linear term in the heat capacity of the hcp phase was observed, and the data yielded a temperature-independent Grüneisen parameter of 2.80 ± 0.05 except within 0.02°K of the transition temperatures where a small anomaly was observed. The bcc data were sufficiently extensive to determine the thermodynamic properties qualitatively throughout the phase. Author (NSA)

**N69-13761#** ARO, Inc., Arnold Air Force Station, Tenn.
**FURTHER EXPERIMENTS ON MIXING AND BURNING OF BOUNDED COAXIAL STREAMS Final Report**
T. H. M. Cunningham and C. E. Peters. Arnold Eng. Develop. Center Oct. 1968 66 p refs
(Contract FY0600-69-C-0001)
(AD-676646; AEDC-TR-68-136) Avail: CFSTI CSCL 21/8

Results of bounded mixing and burning experiments in relatively long ducts are presented. The series of experiments was part of a theoretical and experimental investigation of bounded mixing with combustion within ducts of arbitrary shape. The mixing system consisted of a fuel-rich, H2-O2 rocket stream and a surrounding stream of room-temperature air. A conical mixing duct with cylindrical extensions was used. Twenty-six rocket firings were made in the test series. The system was operated in the downstream choking mode (independent of back pressure) for 19 firings and in the back pressure dependent mode for the remainder of the series. Stagnation pressure ratio between the two streams was varied to provide a range of data. Data presented include axial distributions of wall static pressure and radial profiles of gas composition and pitot pressure at the mixing duct exit. Author (TAB)

**N69-13793#** Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
**TEMPERATURE FUNCTIONS FOR OGIVAL RADOME THERMAL-STRESS ANALYSIS**
Manford B. Tate Aug. 1968 23 p refs
(Contract NOw-62-0604-c)
(AD-676503; APL-TG-1008) Avail: CFSTI CSCL 17/9

Nine temperature functions are required in finding thermal stresses in the main body of a bicentric-ogive radome, and seven in the nosecap. They are formulated and collected in this report for future use in numerical analysis. Of these nine functions, the following are discussed, exemplified, and evaluated numerically: (1) Spanwise distribution of temperature along the outer surface of the radome; (2) Temperature distribution through the thickness of the radome wall; (3) Zonal distributions of thermal strain; (4) Thermal normal-stress resultants; (5) Thermal bending-moment resultants. Author (TAB)

**N69-13812#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
**METHOD OF PRODUCING SUPER-LOW-TEMPERATURES BY DILUTING $^3He$ IN $^4He$**
B. S. Neganov 1968 42 p refs In RUSSIAN
(JINR-P13-4014) Avail: CFSTI

A short description is presented on the principle of operation of refrigeration devices based on the use of latent heat in diluting liquid $^3He$ in $^4He$ and the quantitative analysis is made. In particular, the Joule–Thompson effect in a solution has been considered. It has been stated that, practically, the effect is a result of heating due to friction and the corresponding formulas for calculations have been given. It has been found that dilution specific heat capacity at constant osmotic pressure coincides with the specific heat capacity at a constant volume at any temperatures below 0.1°K and taking this into account the refigeration capacity of the system has been calculated and heat calculations of heat exchangers have been made for cooling the inverse flow $^3He$ in the continuous operating devices. A new type of continuously operating heat exchanger has been suggested and the advantage of its application for cooling the $^3He$ flow. Author (NSA)

**N69-13834#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MIXING OF STREAMS IN A SPACE BOUNDED BY WALLS [SMESCHENIE STRUY V PROSTRANSTVE OGRANICHENNOM STENKAMI]**
B. V. Kantorovich 9 Nov. 1967 34 p refs Transl. into ENGLISH from Tr. Inst. Goryuch. Iskop., Akad. Nauk SSSR (Moscow), no. 56, 1965 p 5–35
(AD-676559; FTD-MT-66-168) Avail: CFSTI CSCL 21/2

The theory of the behavior of the velocities of two streams (liquid or gas) during mixing in a space bounded by walls is studied in order to learn more about the phenomena occurring in fuel combustion processes. The aspect of fuel recirculation due to stream mixing received primary attention. Author (TAB)

**N69-13840#** Naval Research Lab., Washington, D. C.
**THEORETICAL THERMODYNAMIC PROPERTIES OF GASES AT HIGH TEMPERATURES AND DENSITIES WITH NUMERICAL RESULTS FOR HYDROGEN Interim Report**
J. R. Baker, W. H. Goetzhes (Naval Acad.), and H. F. Swift 27 Sep. 1968 52 p refs
(AD-676886; NRL-6675) Avail: CFSTI CSCL 20/13

The partition function corresponding to an equation of state for a high-temperature, high-density gas suggested by J. S. Rowlinson was derived. The equations for selected thermodynamic properties of the gas are obtained from this partition function using statistical thermodynamics. These equations are used to calculate results for the case of hydrogen in the range of temperature between 500K and 3000K and in the range of density between 1 and 2000 amagats. Author (TAB)

**N69-13868*#** General Electric Co., Philadelphia, Pa. Space Sciences Lab.
**STUDY OF EQUILIBRIUM AIR TOTAL RADIATION Final Report**

Sep. 1968 104 p refs
(Contracts NASw-939; NASw-1303)
(NASA-CR-97931) Avail: CFSTI CSCL 22C

From analyses of high temperature air radiance over a range of equilibrium gas properties of interest to superorbital reentry vehicles, the importance of radiation in the vacuum UV spectral region was determined. Due to the large cross section of the radiative mechanisms in the vacuum UV, it was concluded that self-absorption in a radiating gas layer must be included in energy flux analyses, with attention to the wavelength dependence of the absorption coefficient. Coupling between the radiative and convective energy fluxes may significantly reduce the total heat transfer in comparison to that calculated for an isoenergetic layer. The total radiation predictions of Biberman were also analyzed. A fast response total radiation cavity gage system was developed to measure the intensity from a model shock layer through a nonabsorbing optical path, and shock tube investigations of total radiation in the 60,000 ft/sec flight velocity range were perfected which revealed important combined effects of self-absorption and coupling. Total intensity data were obtained to study the contribution from various regions of the wavelength spectrum at simulated flight velocity ranges between 38,000 and 49,000 ft/sec. Windowless as well as long wavelength data obtained with quartz windows are included. A.C.R.

# 34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

**N69-12612#** Library of Congress, Washington, D. C. Aerospace Technology Div.
**FOREIGN SCIENCE BULLETIN, VOLUME 4, NUMBER 11 Review of Selected Foreign Scientific and Technical Literature**
Nov. 1968 62 p refs Transl. into ENGLISH from Russian
Avail: CFSTI

CONTENTS:

1. KOSMOS-166 MEASUREMENTS OF SOLAR X-RAY RADIATION B. Doncov p 1–7 refs (See N69-12613 03-29)
2. ANOMALOUS WATER J. Kourilo p 8–23 refs (See N69-10614 03-06)

**N69-12823#** Joint Publications Research Service, Washington, D. C.
**SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NO. 192**
20 Nov. 1968 146 p refs Transl. into ENGLISH from Russian
(JPRS-46914) Avail: SOD/CFSTI

CONTENTS:

1. ASTRONOMY p 1–6 refs (See N69-12824 03-30)
2. METEOROLOGY p 7–57 refs (See N69-12825 03-20)
3. OCEANOGRAPHY p 58–79 refs (See N69-12826 03-30)
4. TERRESTRIAL GEOPHYSICS p 80–102 refs (See N69-12827 03-13)
5. UPPER ATMOSPHERE AND SPACE RESEARCH p 103–131 refs (See N69-12828 03-13)

**N69-13051#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**JOURNAL OF APPLIED MECHANICS AND TECHNICAL PHYSICS (SELECTED ARTICLES)**
5 Dec. 1967 38 p refs Transl. into ENGLISH from Zh. Prikl. Mekhan. i Tekhn. Fiz., (USSR), no. 5, 1965 p 68–75; 108–111; 162–166
(AD-675569; FTD-HT-23-1266-67) Avail: CFSTI CSCL 20/11

CONTENTS:

1. ON THE VIBROCREEP OF POLYMERIC MATERIALS G. I. Barenblatt et al p 1–13 refs (See N69-13052 03-18)
2. ON LEADING OUT ELECTRON BEAMS FROM VACUUM INTO A GAS THROUGH A GAS DYNAMIC WINDOW A. M. Trokhan p 14–19 refs (See N69-13053 03-12)
3. EXTENDING THE LIMITING RELATIVE LAWS GOVERNING FRICTION AND HEAT TRANSFER TO INCLUDE NONISOTHERMAL GAS FLOW WITH FINITE REYNOLDS NUMBERS A. I. Leont'yev et al p 20–26 refs (See N69-13054 03-12)

**N69-13060** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**RESEARCH LABORATORY OF ELECTRONICS Quarterly Progress Report, Period Ending 31 Aug. 1967**
H. J. Zimmermann, George G. Harvey, and S. J. Mason 15 Oct. 1967 282 p refs
(TID-24203; QPR-87) Avail: CFSTI

CONTENTS:

1. MOLECULAR COLLISIONS p 1–3 refs (See N69-13061 03-24)
2. RADIO ASTRONOMY p 5–15 refs (See N69-13062 03-30)
3. ELECTRONIC INSTRUMENTATION p 17–24 (See N69-13063 03-14)
4. OPTICAL AND INFRARED SPECTROSCOPY p 25–35 refs (See N69-13064 03-06)
5. GEOPHYSICAL RESEARCH p 37–43 (See N69-13065 03-13)
6. MAGNETIC RESONANCE p 45–46 (See N69-13066 03-24)
7. PHYSICAL ACOUSTICS p 47–51 refs (See N69-13067 03-23)
8. PLASMA PHYSICS p 52–72 refs (See N69-13068 03-25)
9. PLASMAS AND CONTROLLED NUCLEAR FUSION p 73–134 refs (See N69-13069 03-26)
10. STATISTICAL COMMUNICATION THEORY p 135–146 refs (See N69-13070 03-07)
11. PROCESSING AND TRANSMISSION OF INFORMATION p 147–151 refs (See N69-13071 03-08)
12. COGNITIVE INFORMATION PROCESSING p 153–167 refs (See N69-13072 03-05)
13. COMMUNICATIONS BIOPHYSICS p 169–189 refs (See N69-13073 03-05)
14. NEUROPHYSIOLOGY p 191–229 refs (See N69-13074 03-05)
15. COMPUTATION RESEARCH p 231–236 (See N69-13075 03-19)

**N69-13159*#** Texas Univ., Austin.
**AN APPLICATION OF SIMILITUDE TO MODEL DESIGN OF A SOIL-PROJECTILE SYSTEM**
Katsuyuki Awoshika and William R. Cox Washington NASA Nov. 1968 121 p refs
(Grant NsG-804)
(NASA-CR-1210) Avail: CFSTI CSCL 20K

A model design by means of similitude, or dimensional analysis, was made for the simulation of a space capsule landing on soils. In order to examine the validity of the model design for sands, a series of cone model tests was carried out on Ottawa Sand and Colorado River Sand. The weights of cone models were 43.0 and 129.5 pounds. The impact velocity of models was in the relatively low range of 10 to 23 fps. The validity was checked by examining the agreement of the measured variables from one of the models with the prediction of variables from the other model. The results were satisfactory. A model design law is discussed for clayey soils impacted with projectiles consisting of a circular plate, a wedge, and a sphere. The application of this model design law to vertical impact tests of a circular plate, a cone and a sphere on a clay was examined. Author

**N69-13170#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**UKRAINIAN JOURNAL OF PHYSICS Selected Articles**
27 Sep. 1967 16 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 11, no. 2, 1966 p 152–158, 206–208
(AD-674226; FTD-HT-67-401) Avail: CFSTI CSCL 20/9

CONTENTS:

1. EFFECT OF REDISTRIBUTION OF ELECTRONS IN A PLASMA WAVEGUIDE IN A FIELD OF A STRONG ELECTROMAGNETIC WAVE A. M. Fedorchenko p 1–6 refs (See N69-13171 03-25)
2. COMPOUND WITH STRUCTURE TYPE $W_6Fe_7$ IN AN Mo-Ni-Si SYSTEM R. V. Skolozdra et al p 7–9 refs (See N69-13172 03-26)

**N69-13181#** Library of Congress, Washington, D. C. Aerospace Technology Div.
**FOREIGN SCIENCE BULLETIN, VOLUME 4, NO. 12**
Dec. 1968 79 p refs
Avail: CFSTI

CONTENTS:

1. THE SOYUZ-3 MISSION B. Mandrovsky p 4–24 refs (See N69-13182 03-31)
2. SCIENCE'S SECOND MOST IMPORTANT ASSIGNMENT: HIGH-TEMPERATURE SUPERCONDUCTORS Z. Litynski p 25–34 refs (See N69-13183 03-26)
3. DEVELOPMENT AND APPLICATIONS OF SOME SOVIET ALUMINUM ALLOYS D. Vvedensky p 35–43 refs (See N69-13184 03-17)

**N69-13291#** National Bureau of Standards, Washington, D. C. Office of Standard Reference Data.
**NATIONAL STANDARD REFERENCE DATA SYSTEM, APRIL 1968 Status Report**
Edward L. Brady, ed. Jun. 1968 125 p refs
(NBS-TN-448) Avail: SOD $0.70

This report summarizes the status of activities of the NBS Office of Standard Reference Data as of April 1968. It provides a detailed review of the data compilation activities within the seven broad categories of the technical scope of the program: (1) nuclear data, (2) atomic and molecular data, (3) solid state data, (4) thermodynamic and transport data, (5) chemical kinetics, (6) colloid and surface properties, and (7) mechanical properties. Progress in data systems design and development and in information services is reviewed. Certain problem areas of the program are identified. The appendix includes: (1) a listing of information and data centers associated with the Office of Standard Reference Data, (2) publications of the National Standard Reference Data System, and (3) a listing of organizations, groups, or individuals compiling or evaluating data. Author

**N69-13382#** Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.
**THE SEMINAR AT THE PHYSICS LABORATORY [IL SEMINARIO DEI LABORATORI DI FISICA NEL QUADRIMESTRE GENNAIO-APRILE 1968]**
6 May 1968 58 p refs In ITALIAN; ENGLISH summary
Seminar held at Rome, Jan.–Apr. 1968
(ISS-68/15) Avail: CFSTI

Summaries of lectures presented to the seminar held at the Istituto Superiore di Sanita are compiled. Included are articles on subjects such as acoustics, ferroelectricity, inelastic scattering, biochemistry of slime molds, and DNA in pneumococcus. Transl. by F.O.S.

**N69-13651#** Toronto Univ. (Ontario). Inst. for Aerospace Studies.
**INSTITUTE FOR AEROSPACE STUDIES Annual Progress Report, 1968**
Oct. 1968 241 p refs
Avail: CFSTI

The UTIAS program of research in the upper atmosphere for 1968 is summarized. Facilities for the complete instrumentation of rocket nose cones were developed. Rocket experiments were conducted to provide a nose cone design which was ejectable, but vacuum tight. In cooperation with the Canadian aerospace industry the Institute prepared a proposal for a survey satellite to study Canada's natural resources. The specific areas of research included are: mechanics of rarefied gases; plasmadynamics; hypervelocity flows, implosions and impact; space power generation, advanced propulsion, and earth resource satellites; aerodynamic noise; subsonic aerodynamics; aerospace flight dynamics; materials science and structures; rocket research; molecular beams and surface interactions; high temperature gas dynamics and gas physics; laser excitation diagnostics; flight transportation; and industrial and architectural aerodynamics. B.P.

**N69-13674#** Aeronautical Systems Div., Wright-Patterson AFB, Ohio. Deputy for Engineering.
**RESEARCH AND DEVELOPMENT EFFECTIVENESS PROGRAM 1969 (RDE 69) A MANAGEMENT TOOL TO ALLOCATE THE BUDGET OF A RESEARCH ORGANIZATION**
Robert R. Jurick and James F. Bittle, II Jul. 1968 138 p
(AD-676269; ASD-TR-68-23) Avail: CFSTI CSCL 9/2

A formulation and digital computer program is presented as a management tool to allocate the budget of a research organization. The value of a specific research task is defined and an optimization technique is employed to maximize the total value achieved for a given yearly budget constraint of the organization. A maximum of 250 research tasks may be considered. The program performs a yearly optimization for up to five years. It generates a number of reports which indicate the progress of each research task during the given time period and the effect of this progress on other organizational entities. Author (TAB)

**N69-13726#** Joint Publications Research Service, Washington, D. C.
**SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NO. 193**
29 Nov. 1968 66 p
(JPRS-46971) Avail: CFSTI

CONTENTS:

1. ASTRONOMY p 1–6 (See N69-13727 03-30)
2. METEOROLOGY p 7–11 (See N69-13728 03-20)
3. OCEANOGRAPHY p 12
4. TERRESTRIAL GEOPHYSICS p 13–17 (See N69-13729 03-13)

5. UPPER ATMOSPHERE AND SPACE RESEARCH p 18–55 (See N69-13730 03-29)

N69-13751# Purdue Univ., Lafayette, Ind. School of Electrical Engineering.
**EIGHTH SEMIANNUAL RESEARCH SUMMARY, JANUARY–JUNE 1968**
Jun. 1968 126 p refs
(Contract N00014-67-A-0226)
(AD-676321) Avail: CFSTI CSCL 6/16

Reviews are given of research reports in the fields of medical and life sciences, control and information systems, electric power systems and energy conversion, electromagnetic fields, communications sciences, nonlinear circuits and systems, materials and electronic devices, and agricultural remote sensing. TAB

N69-13789# Northwestern Technological Inst., Evanston, Ill.
**ON THE EXPLICIT SOLUTION OF A SPECIAL CLASS OF LINEAR ECONOMIC MODELS**
Adi Ben-Israel, Abraham Charnes, Arthur P. Hurter, and Phillip D. Robers Aug. 1968 18 p refs
(Contracts N00014-67-A-0356; DA-31-124-ARO(D)-322; Grant NSF GP-7550)
(AD-676517; SRM-215) Avail: CFSTI CSCL 12/2

In this paper we give explicit solutions for a class of linear (inequality) economic models heretofore treated by linear programming. These solutions are quite elementary and the decision criteria given are easily interpreted. Integrality constraints are naturally incorporated in our solutions, without resorting to special integer programming algorithms. The explicit solutions may involve the inversion of a single matrix but even this is not necessary for the three examples in capital budgeting, production planning and input-output analysis given below. Author (TAB)

N69-13790# RAND Corp., Santa Monica, Calif.
**A REAL TIME METRIC FOR THE DISTRIBUTION OF SERVICEABLE ASSETS**
Bruce L. Miller Oct. 1968 41 p refs
(Contract F44620-67-C-0045)
(AD-676641; RM-5687-PR) Avail: CFSTI CSCL 15/5

The memorandum describes a Real Time METRIC (a Multi-Echelon Technique for Recoverable Item Control) stockage model to aid decision makers in distributing recoverable spares between a depot and the bases it serves. Instead of using the current concept of base levels, RTM makes decisions about spares on an as-needed basis in continuous time, using current asset information. This approach requires information on the whereabouts of all spares in a system at any one time. Two RAND research efforts provided data that were used in simulations to compare RTMs effectiveness against that of the current concept of base levels: an F-4C and F-4D engine management study, and a 100-item distribution and depot scheduling model that was part of the Master Study Plan of the Advanced Logistics Systems Center. Author (TAB)

N69-13820# Carnegie-Mellon Univ., Pittsburgh, Pa. Management Sciences Research Group.
**SIMPLE STOCHASTIC NETWORKS: SOME PROBLEMS AND PROCEDURES**
D. P. Gaver, Jr. and John M. Burt, Jr. Jul. 1968 42 p refs
(Contracts Nonr-760(24); Nonr-1228(10))
(AD-676891; RR-142) Avail: CFSTI CSCL 5/1

The paper provides an analysis of stochastic networks, that is networks whose underlying link times are expressed as random variables. Analytic and Monte Carlo methods for finding the distribution function (or parameters thereof) of the maximal time through such a network are discussed. The first section, which considers analytical procedures, emphasizes networks whose link times are given by probability functions from an exponential family. It is shown that the Markov property of the exponential distribution may be utilized to simplify analytic computations. In the second section Monte Carlo techniques are described which provide useful information on project completion time distributions. It is argued that these easily applied techniques are more economical (fewer computations are required) than naive simulation. Throughout the paper, we suggest a blending of the analytical and simulation procedures into an efficient overall method for studying stochastic networks. Author (TAB)

N69-13876# Lincoln Lab., Mass. Inst. of Tech., Lexington.
**GENERAL RESEARCH Quarterly Technical Summary Report, 1 May–31 Jul. 1968**
Frederick C. Frick, V. Alexander Nedzel, Stephen H. Dodd, Melvin A. Herlin, Jerome Freedman et al 11 Sep. 1968 48 p refs
(Contract AF 19(628)-5167)
(AD-675291; ESD-TR-68-232) Avail: CFSTI CSCL 5/2

This Quarterly Technical Summary covers the period from 1 May through 31 July 1968. It consolidates the reports of Division 2 (Data Systems), Division 3 (Radio Physics), Division 4 (Radar), Division 7 (Engineering), and Division 8 (Solid State) on the General Research Program at Lincoln Laboratory. Author (TAB)

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